AUG 7 1926

Engineering News-Record

Devoted to Civil Engineering and Contracting. McGraw-Hill Publishing Company, Inc.

August 5, 1926

Raising Submarine S-51: Pioneer Engineering in Deep-Water Salvage

Keeping Salt Water Out of Lock-Controlled Waterways

Deep Caisson Cellar Walls Braced by Floor Steel Before Erecting Columns

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

McGraw-Hill Publishing Co., Inc.
JAMES H. McGRAW, *President*
E. J. MEHREN, *Vice-President*

FRANK C. WIGHT
Editor

Volume 97 NEW YORK, AUGUST 5, 1926 Number 6

Welding Developments

SHARP emphasis is given to the prominent position of fusion welding for structural steel building framework by the events of the past week. Announcement is made that the Westinghouse Electric & Manufacturing Co. is to have a large building constructed at its Sharon plant, of all-welded construction; and the contractor for fabrication and erection is the American Bridge Co., the largest concern in the field of fabrication and therefore presumably the most conservative. The contract, involving some seven or eight hundred tons, is large enough to mark the real entry of arc welding into the commercial structural field. On the other hand, it probably is in effect an experiment—though one of large size—so far as the contractor is concerned. That kind of experimenting means progress at all events; it is sure to throw very clear light on the problems, possibilities and difficulties of welding as a regular assembly method. Simultaneous with this announcement an important series of tests of welded structural connections was carried out at Pittsburgh, the Westinghouse company again being a principal here. That the results were in all respects favorable to welding was perhaps a foregone conclusion, since the tests were mainly of demonstration character. But their variety and detail character showed how deeply the welding interests are digging into the structural problem. This again is a sure forerunner of progress. Incidentally, the riveted members included in the test program showed uniformly high strength and elastic properties, representing substantially full utilization of the material. This suggests that the efficiency margin on which welding can work is moderate. The new art must achieve almost perfection to gain an advantage.

Automatic Train Control

FOLLOWING a railway accident such as that which occurred near Pittsburgh recently most of us are inclined to sit back complacently and join in singing the refrain, written several years ago by the Bureau of Safety of the Interstate Commerce Commission, which runs, "Had some form of automatic train control been in operation this accident probably would not have occurred," feeling that the railroad companies are doing little or nothing toward bringing the train control millenium about. It gives us, therefore, somewhat of a shock—a pleasant one—to find in a recently published statement how much really has been done by the railroads along this very line in the few years since the work of installing automatic train control was started. The first order directing the general installation of test sections of train control on the major railway lines was issued just four years ago. At that time the amount of such equipment in actual service was negligible and knowledge on the subject as little widespread. As a result the railroad companies entered into a period of experimenting with various types of control which brought us up to the summer of last year with little done toward completing the installation of train control upon the railway divisions covered by the commission's first order. Now, however, things have changed. The actual work of installing the equipment is being carried on vigorously in many places. Up to July 1 the installation on 5,841 miles of track had been completed with work on 1,662 miles more under way, a total of 7,503 of the 7,770 miles included in the commission's first order. Moreover, the equipping of about 3,700 locomotives with train-control devices is a necessary part of this undertaking. In relation to the 250,000 miles of railway in the country the total now equipped is small, but when it is realized that the art is new and the work slow and expensive it will be seen that the present accomplishment is a highly creditable one.

Construction Plant Planning

THE bridge designer has been credited, in popular legend at least, as the one among engineers who pinned up one pier layout and superstructure plan against another in the greatest multiplication to arrive at his final choice of efficient and economical structure. Almost this practice has characterized recent large construction plant planning. Last week the designer of the construction plant for the Mystic iron works told of the several arrangements considered and discarded in arriving at the one employed. Six weeks ago another contributor told of five plans studied for choice of a plant for building construction. On Long Island there has just been completed a building of moderate size where after considering four other plant plans a fifth was adopted with a notable gain in economy. There is a construction plant now working on a $25,000,000 power plant in New York City which is the final choice of nine different plans studied. So the count might go on. Further enumeration, however, would signify only extension of a practice. Skilled contractors today are giving as careful design thought to temporary construction plants as are the directing engineers to the permanent structure being built. This condition has been brought out of close competition for work but more fundamentally out of the fact that construction is primarily a succession of co-ordinated machine operations and must be technically planned and directed.

Improved Macadam Roads

FEATHER edges, once common, have long had small place in road surfacing of stone and gravel. Practice, however, has been slow to depart from a section thinner at edges than at crown. The boldest designers only have made the broken stone road of one thickness for its full width. Now it is being frequently suggested that a leaf be taken from recent common practice in concrete pavement design and make macadam roads

with thickened edges. The article in this issue on new designs for macadam roads therefore has special interest as the basic idea is increase of edge strength and stability. The suggested ways, each with its argument, are adequately explained in the article and may be compared and chosen from as individual judgment decides. It is important to note, however, that all embody the idea of subgrade stability as a fundamental in strength design. Particularly is the stability of subgrade at the pavement edges sought by drainage and the use of subbase materials and structures which decrease capillarity. This is erecting practice on basic reasoning. Indeed in all the article will be found a backbone of fundamental road engineering which deserves more general recognition than it is getting because of our absorption in pavement design. There must remain for a long time a large place in our highway program for roads of the macadam type. They, therefore, cannot be too deeply studied. Even if we accept the extreme view that they should be considered only as a transition type in the final development to rigid pavements they require study so that they may best fulfill their function as a foundation to the future hard surface.

The S-51's Future

MANY reflections present themselves in reading Commander Ellsberg's fascinating tale of the S-51, reproduced in rather dry reportorial style on another page. The unflagging determination of the men on the job to put it through in spite of a most intense strain of grinding labor and discouragements, and against every obstacle, is just one of the high-light features of the story. But looking ahead rather than back to the events of last winter and spring raises the question of what shall be done with the ship, heroically lost and heroically saved. Its physical condition is excellent; except for mechanical injuries and the loss of water-soaked finish and equipment it is as good as when the ship was new. The frames and plating are quite unaffected by their nine and a half months on the ocean bottom. From the standpoint of efficiency and prudent management the S-51 should be saved by refitting. On the point of cost, it may be said that the submarine was worth about $3,000,000 when new; it can be refitted, quite as good as new, for $600,000. Unfortunately nothing can be done toward undertaking this work until Congress approves and makes the necessary appropriation. The question at issue is the reclamation of one of our most modern naval units at a fraction of the cost of replacement; in other words a rather simple question of economy. Since the raising of the ship was engineering work—of high grade—engineers may take a proper interest in putting this work to good account by urging their congressmen to act on a reconditioning appropriation.

A Civil Service Question

INQUIRY among engineers in the municipal service leads us to believe that many of them consider civil service commissions necessary evils at best. This opinion is brought to mind by an editorial in the Minneapolis *Journal* in which it was stated that the City Hall Debating Society was about to debate a resolution proposed by Alderman Ryan: "Resolved, that the Civil Service Commission is costing the taxpayers of Minneapolis from $150,000 to $200,000 a year in decreased efficiency." The journal cites an ex-mayor and present member of the school board as saying that the civil service, in Minneapolis at least, "has not produced the efficiency that we encounter in every day business life . . . there are many cases where there would be greater efficiency if the department head had greater authority." The *Journal* enlarges upon this by saying among other things: "The idea of expecting department heads to get efficient work out of their subordinates when deprived of all authority to discipline or dismiss them, no matter what the cause, is certainly fallacious. . . . The commission has power without knowledge. The department heads have responsibility without authority. . . . We think the estimate of the cost of civil service in inefficiency altogether too low. It affords complete protection for sinecures, shirks and incompetents. The cost of it to the taxpayers is very heavy." With much of this many engineers will doubtless agree, still adhering, however, to the "necessary evil" dictum already cited. But does this picture the civil service commission at its best? There are those who urge that the activities of such bodies should not stop with (1) certifying the fitness and rank of candidates for office and (2) once appointed, protecting them from removal. These advocates would go further and make it the duty of such commissions to keep tab on the efficiency of appointees. The idea has been put into use to some degree here and there. It deserves wider trial.

Over a Billion Gallons a Day

HOT weather in Chicago last month sent the maximum city water pumpage to 1,100 m.g.d. New York must have used and wasted over a billion gallons a day on July 22, for on that day the official records showed that 995 m.g. of water was delivered by the city works alone, while private companies operating within Greater New York constantly supply the equivalent of a fair-sized city. These ever mounting figures show something of the water problems of our cities today, for what happens in our largest cities is repeated proportionately down the line to the smallest, except as affected by variations in water-waste control and by industrial demands. Chicago pumps all its water. Under normal conditions most of New York is supplied by gravity but deficient rainfall and low storage in the Catskill system during the first half of 1926 forced New York to draw heavily upon the old Croton and Brooklyn systems, which in turn meant pumping a considerable per cent of the total supply. Persistent urging by the Chicago water engineers that the wanton waste in that city ought to be cut down by meters, or at least that the wasted water should be paid for, was of no avail, but last year the federal government compelled the city to adopt a ten-year universal metering program as a condition of the Lake Michigan drainage canal diversion, to keep the city's sewage from its water supply. In New York City, as we stated a week ago, a feeler on universal metering was put out recently, but no definite campaign to that end has been undertaken since the storm of protest that arose when metering was officially advocated ten years ago. This year's deficient rainfall and the return to a considerable amount of pumping of water from the Croton and Long Island gathering grounds, with its attendant expense, point to the need for metering the entire water supply of New York City.

Western Irrigation and Its Future

FAR-SEEING men have recognized for some time that the business of reclaiming arid lands in the West by federal construction of irrigation works is near its end. The passage of the Reclamation Adjustment bill and the establishment of a forty-year basis of interest-free repayment of reclamation costs by the beneficiaries are the latest acts in the drama. That Congress nevertheless appropriated initial sums for the construction of half a dozen new development projects, again under the threadbare pretence of repayment by the landholders, is of only momentary significance.

For several years the end of reclamation has been threatened, by the torpid attitude of Congress toward the responsibilities which arose out of the critical state of reclamation following the post-war inflation. Instead of facing these responsibilities, Congress time and again yielded to the strident demands of its Western members. It made no attempt to cure the evils of reclamation, but has finally thrown a sop of charity to the complainants and turned its back on the problem.

Reclamation has now been reduced to mere philanthropy, and this of peculiarly unsound type. Twenty-four years ago it was planned as a sound business proposition. There then existed in the West the possibility of creating large irrigation enterprises on public lands, to give opportunity for homesteading. The Western states were poor, and for other reasons unable to undertake such development. There were also difficult water-right problems. Therefore the federal government took up the work. After creating large value in worthless desert land, the government was to be repaid by the homesteaders; that was the hopeful plan—the basis and sole justification of a new and radical national-development policy which trespassed on the domain of local and private enterprise.

It was intended to develop public lands, but almost from the beginning the system was applied mainly to privately owned land, which naturally clamored loudest for improvement. Thus, the whole purpose of the law was defeated at the very start. The repayment term, originally set at ten years without interest, was soon increased to twenty years, and later was further increased both by the executive through the simple expedient of deferring notice to begin payment and by Congress through various Relief Acts, until now it has been fixed (under the cloak of a discretionary proviso) at forty years, still without interest. Thus the system progressively decayed.

As matters stand now, the landholder whose property is improved at public expense refunds only a small fraction of that expense. If this were not enough to characterize the arrangement as absurdly philanthropic, the recently enacted adjustment bill would do so quite fully. That bill cancelled some fifteen millions of dollars of the landholders' debt, and "suspended" another similar item. The losses which these amounts represent arose from risks inseparable from any enterprise, which of course are a necessary part of its cost. Thus Congress has in effect declared that the public shall stand the losses in irrigation development, while the land owner may take the cream. Quite obviously this is not business, but philanthropy.

The bill and its history mean, moreover, that land reclamation—when carried on by the government and subject to political log-rolling—does not pay. To palliate this humilating showing, pleas have been made in recent years that the development of arid land needs to be subsidized, and, again, that the upbuilding of the West is so desirable that the nation at large ought to subsidize it. These arguments have never met with much sympathy, however; the average man can see no more reason for subsidizing irrigation than for subsidizing the development of blast furnaces or of lumber mills or cement factories. And, when examined dispassionately, arguments for subsidized irrigation are after all nothing more than an admission of failure and a grasping at straws to rehabilitate a lost cause.

Understanding of the hopeless situation of Western reclamation is gradually spreading wide and deep. A typical example of the public reaction may be cited from the Philadelphia *Bulletin* of a few weeks ago: "While Western farmers complain that surplus crops are impoverishing them . . . Congress calmly proceeds to vote vast sums of money for dams to irrigate thousands of acres which it is proposed to bring under cultivation. And this in the face of the costly experience with existing reclamation projects." And again, "Federal state-aid grants . . . are fast becoming an abuse and a scandal. The whole array of these schemes should be scrapped."

Since the existing reclamation system has now been put through bankruptcy by Congress, the new projects which Congress is proposing to undertake are obviously hopeless. The most fertile irrigable lands have not been able to repay their development cost under federal administration. Yet, where these cost $45 to $80 per acre to develop, the new projects will cost upwards of $150 per acre, and so are clearly condemned to failure even before they are begun. It may be expected that a future Congress will take a businesslike view and will stop work before great sums have been wasted.

What is to take the place of the past reclamation system is a question for the future. Irrigation development by local and private action has been checked and warped by the influence of the federal work, for bond-issue money cannot compete in a healthy way with interest-free public money. The bad morale of the politically controlled federal system also has affected the other systems, with serious results, among them a harmful effect on public credit. Last year a Western financial man pointed out in a notable address before Oregon irrigationists that the whole structure of Western municipal and state credit has been impaired by the unsound irrigation security situation.

Nevertheless, sound local irrigation development is possible, as attested by many flourishing district projects. Sound development by states is no doubt just as feasible, though so far not extensively tried. State financial resources, moreover, are adequate for many undertakings that are beyond the reach of local financing. Thus, great possibilities exist in state and local work for future irrigation development.

Federal participation as heretofore practiced has come to its end, as already said. Whether and how federal co-operation may be possible in the future must await the development of a new system. No such system has yet been outlined, but it is clear that it must be erected on a secure banking basis and must be placed beyond the influence of politics and Congressional beneficence. It yet remains to be proved that such a system can be set up and successfully maintained. Unless it can, however, federal reclamation has seen its last days.

Deep Caisson Cellar Walls Braced by Floor Steel Before Erection of Columns

Substructure Problems in Barclay-Vesey Building of New York Telephone Co. — Permanent Floor Steel Used as Bracing of Caisson Cofferdam Before Columns Were Set—Cable Duct Entrances

By Carlton S. Proctor
Moran, Maurice & Proctor, Consulting Engineers, New York

THE story of the design and construction of the substructure of the recently completed Barclay-Vesey Building of the New York Telephone Co. is of interest not only because of the record size of the operations but because of their unusual features and new departures, and because of the fact that the

FIG. 1—TIMBER AND STEEL BRACING IN LOWER PART OF SUBSTRUCTURE, BARCLAY-VESEY BUILDING

design took advantage of and further developed the new methods required in the design of the New York Federal Reserve Bank substructure. For example, here for the first time permanent steel cross-lot struts were placed and wedged in both directions prior to the completion of general excavation and before the placing of columns or grillages, thus serving as cofferdam bracing for both temporary and permanent conditions and saving approximately half of the timber cross-lot bracing which would otherwise have been required; and here caisson cutting edges were landed and laterally supported on bedrock shoulders above the final general excavation subgrade level after the caissons had been sunk through open cribs and fill.

Site and Subsoil—Occupying the entire block between West and Washington Sts., Barclay to Vesey St., a rhomboidal area about 212x255 ft., the building has in its substructure five cellar stories, the lowest of which finishes 70 ft. 6 in. below curb level. West St. borders the Hudson River, and at extreme flood tides the river rises to submerge it. Years ago the site of the building was outside of the shore line of the river (see Fig. 2), and later it was reclaimed by sinking boulder-laden barges and cribs. Correspondingly the preliminary subsoil borings indicated filled ground containing timber and boulder cribwork and comprising filling materials of almost every character.

Deep-Cellar Plan Adopted—Many separate studies were made covering varying foundation schemes with varying cellar volumes, to develop the economic comparison between the designs and to show the net costs of cellar space produced. From these studies it appeared that the unit cost of cellar space decreased rapidly as the volume of such space was increased, and that the total space down to rock could be utilized at a very low comparative unit cost of space production. As the company's business requirements are such that it is able to make effective use of all the cellar space, the decision to cofferdam the entire site and to carry the cellar excavation to maximum depth without involving rock excavation was determined.

The first major problem in the design was that of the lateral support of the cofferdam walls. Many factors contributed to the difficulty of its solution, and pointed to the desirability of introducing new and previously untried methods. Among these factors were (1) the unusual shape of the site, which included two obtuse and two acute angles; (2) the peculiar character of the soil; (3) the fact that the walls must support a 75-ft. maximum active hydrostatic head; and (4) the congestion of working space (especially headroom) between the *C* and *D* floor levels of the excavation which would result from the use of the large volumes of timber required by the customary methods of temporary bracing. These considerations led to the adoption of a scheme of support which, while unprecedented, was essentially a further development of the

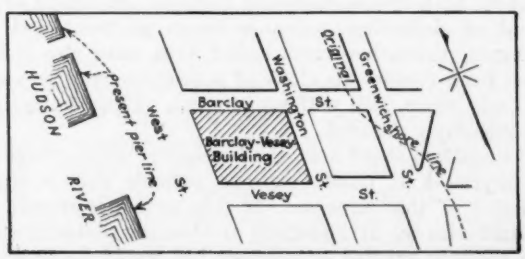


FIG. 2—LOCATION AND SITE PLAN
Old shore line was east of building site; miscellaneous fill including rock-filled timber cribs complicated the foundation work.

supporting principles used in the New York Federal Reserve Bank foundations (*Engineering News-Record*, April 15, 1926, p. 598) and probably would not have been attempted without the successful results of that bracing installation and the data which it furnished.

Basement floor *C* was to be 27 ft. above the average level of the caisson cutting edges, or 43 ft. below curb. On the triangular basis of hydrostatic pressure against

the cofferdam walls, 63 per cent of the cross-lot bracing would have been required below basement *C*, down to subgrade or basement *E* floor. The interior cellar design required a boiler room and coal bunker cutting through *C* floor, which precluded the possibility of designing this slab as a pressure-resisting plane of support. It was therefore necessary

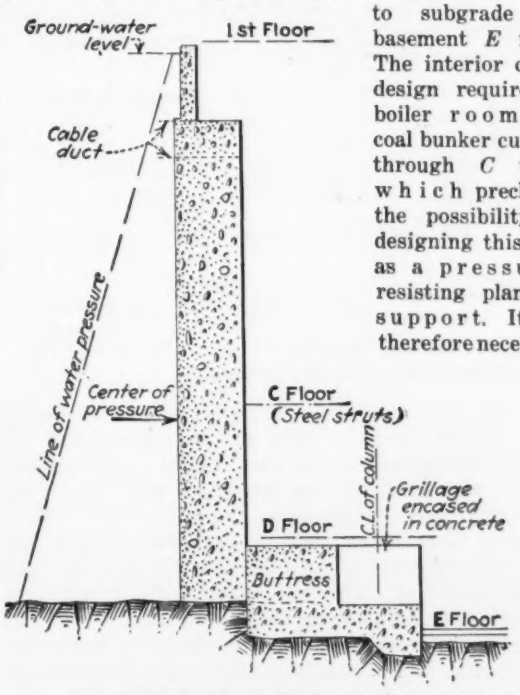


FIG. 3—TYPICAL SECTION OF CELLAR WALL
Vertical E-W section. Most of inward pressure on caisson wall carried by steel struts at level of basement floor *C*. Foot of caisson supported by interior buttress.

to provide at least the permanent cofferdam support at this level through steel struts acting in both directions. The cellar requirements permitted both *D* and *B* floor slabs to be designed as continuous diaphragms of lateral support, so that recourse to steel struts for the permanent lateral support was required at the *C* floor only. But since steel members had to be used here for permanent support, it was seen that they could be made to serve for temporary cofferdam support too, if adequately supported and maintained and properly pre-stressed prior to excavating below *C* floor level and prior to the installation of columns.

Use of Steel Struts—It was therefore decided to utilize the *C* floor tier of struts to provide the maximum amount of temporary lateral support. Timber bracing was installed in both directions down to basement *C*, from which level timber piles were driven to rock in groups of four at each point of intersection between north-south and east-west steel struts. These piles were so capped that they provided lateral and vertical support for the steel struts, with provision for adjustment in any direction to maintain perfect alignment (Fig. 6). The steel struts were so built, of members in pairs, as to admit the columns later, without disturbing the struts.

The design made use of the shape of the site by providing for the lateral support at the two acute corners through the triangular floor slabs, and consequently in these corners timber bracing was carried down to subgrade. This permitted the omission of the north-south steel struts beyond the obtuse corners. Pile supports were provided for the east-west steel struts beyond their last intersection with the north-south strut system.

After installing and supporting the entire tier, all steel struts were wedged up to a predetermined stress and the excavation then carried to subgrade, the pile supports being cross-laced as the excavation proceeded. All strut splices had been provided with milled ends and had been punched short and drawn up by drift pins,

FIG. 4—TIMBER BRACING IN UPPER PART OF EXCAVATION

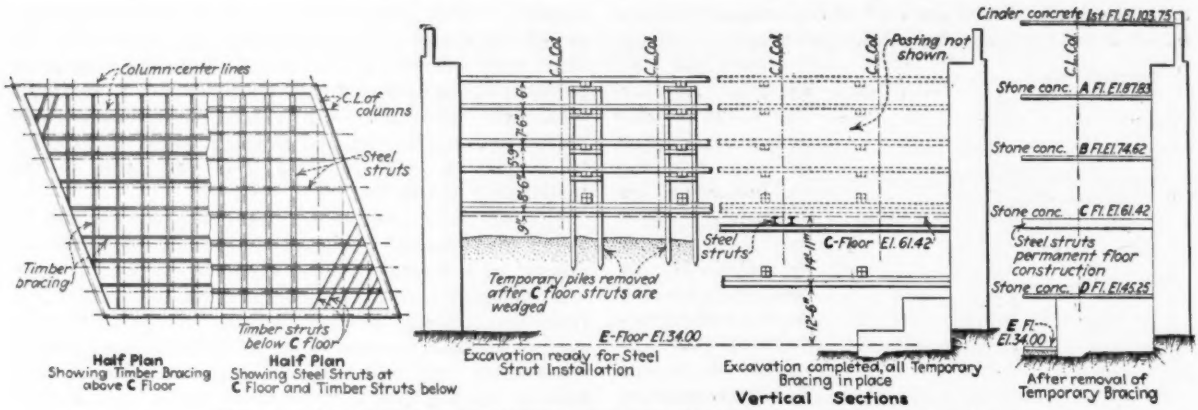

Column center lines
C.L. of columns
Steel struts
Timber bracing
Timber struts below C floor
Half Plan
Showing Timber Bracing above C Floor
Half Plan
Showing Steel Struts at C Floor and Timber Struts below
Posting not shown
Temporary piles removed after C floor struts are wedged
Steel struts
C-Floor El. 61.42
E-Floor El. 34.00
Excavation ready for Steel Strut Installation
Excavation completed, all Temporary Bracing in place
Vertical Sections
Cinder concrete 1st Fl. El. 103.75
Stone conc. A Fl. El. 87.83
Stone conc. B Fl. El. 74.62
Stone conc. C Fl. El. 61.42
Steel struts permanent floor construction
Stone conc. D Fl. El. 45.25
E Fl. El. 34.00
After removal of Temporary Bracing

FIG. 6—STEEL STRUTS ARRANGED FOR SUBSEQUENT PLACING OF COLUMNS

to prevent any joint make-up when the struts were wedged.

Pre-Stressing the Struts—Steel wedges were designed to introduce a predetermined compression when driven a predetermined distance. The careful records of the wedging of the Federal Reserve Bank struts had afforded much information which proved extremely valuable here. These records had demonstrated (1) that by the methods just described it was possible to eliminate joint make-up; (2) that the effect of temperature changes in the struts produced only transitory stress changes in the struts; and (3) that the effects of restraint at points of support, restraint at column connections, and location of wedging points, were negligible. With the assurance afforded by these records the wedges were here hand-driven by the use of lengths of heavy rail.

Two wedging points were provided in each strut, one at each end, at the point of support one bay away from the cofferdam wall. Each strut was wedged at both ends at the same time, but only a third of the total predetermined stress was wedged in at any one driving, and no strut was re-wedged until equivalent stress had been introduced in the entire tier. While all struts were being thus progressively wedged up, careful records were being continuously kept of the level and alignment of each strut, particularly at points of intersection or support, and micrometer caliper readings were made to check the amount of stress in each strut. Similar records and readings were continued until all struts had received their permanent support from the columns.

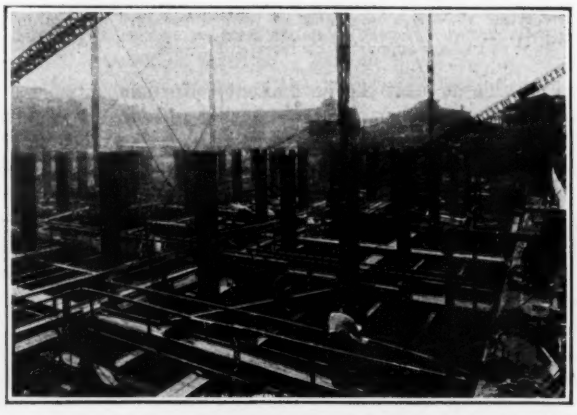


FIG. 7—ERECTION OF STEELWORK—LAST STAGE BEFORE RELEASE OF TIMBER BRACING

The predetermined amount of stress to be wedged into each strut was approximately 60 per cent of the calculated stress which each strut must permanently take, and was the amount of stress which would be thrown on to the strut when the excavation had been carried to the underside of the timber bracing tier at the *D* floor level. At the time of installation of the steel struts the pressures above this level were being carried on timber bracing, and this bracing would be kept continuously wedged until the *A* and *B* floors were concreted and set up. In order that these two floors would take their proportion of stress, they must either compress when the timbers were removed, which would require an inward movement of the walls, or the floor slabs must be pre-stressed, which would be expensive and difficult. The cofferdam wall, 8 ft. thick, was so stiff that it would move inward at the *A* and *B* floors

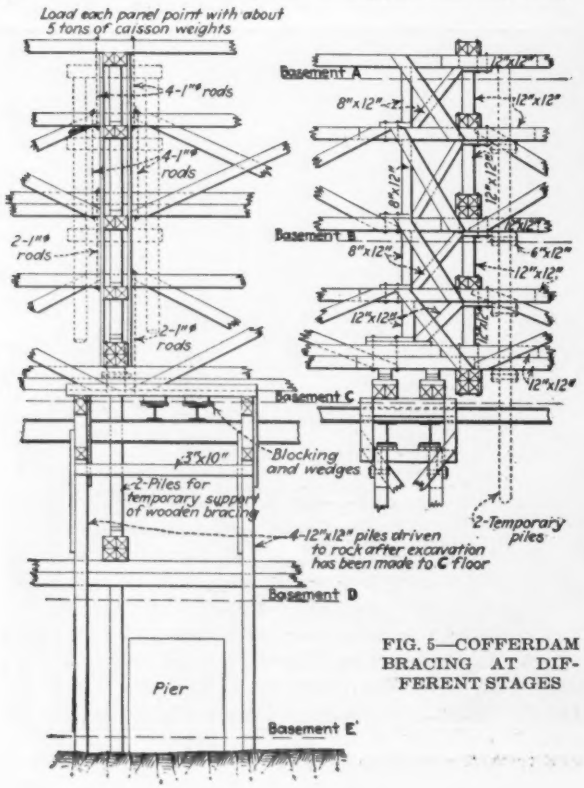


FIG. 5—COFFERDAM BRACING AT DIFFERENT STAGES

only with a corresponding (though smaller) movement at the *C* floor level, and therefore additional compression of the struts at the time of timber removal would be necessary in order to prevent the walls from cantilevering much of the intended *B* floor stress into the struts. The amount of stress pre-wedged into each strut was therefore such as to permit the desired additional strut compression resulting from the wall movement when the timber bracing was removed.

After the general excavation had been completed the column piers were constructed on bedrock, and the column grillages and bases were placed. The columns were then lowered to place between the steel struts and the permanent connections of struts to columns were made.

Timber Bracing—As noted above the use of the permanent steel struts for temporary support permitted a saving of approximately 50 per cent of the cross-lot timber bracing which would have been required had all temporary support been provided by the usual method of timber bracing; but the major advantages of this system were the greatly increased working space provided below the *C* floor, and the very important increase afforded to the safety of the operation by the elimination of the many hazards inherent to the employment of such a closely congested mass of timber as would have been required from the *C* floor to rock. As it was, only one tier of timber bracing was used below the *C* floor, and that was at the *D* floor level.

All timber bracing was pre-stressed, so as to prevent the inward motions of the walls, by exactly the same method of double wedging as was developed for the Federal Reserve Bank job.

In the Washington St. end of the lot, rock level averaged 9 ft. below *D* floor, but in the West St. end the rock pitched off to a depth of 17 ft. below *D* floor. The soil between *D* floor and rock consisted of a boulder and silt formation, through which it was impossible to drive vertical sheeting, and a sufficient quantity of water was flowing through seams in the rock floor to make the use of horizontal sheeting for interior piers both difficult and expensive. Furthermore, the construction of interior piers would have destroyed the supporting value of the soil below the *D* floor level, which would have required the provision of considerable additional bracing and would have highly stressed the lowest section of the walls. By progressively installing the four lines of piers adjacent to the outside walls before excavating below *D* floor, and by extending these piers to the caisson concrete face, a series of buttresses was created which provided the necessary lateral support to the caissons to permit carrying the excavation to the rock floor without additional timbering, and construction of the *E* floor with its sumps and pits.

During the sinking of the caissons considerable difficulty was caused by the cribbing and boulder fill, which was quite open and therefore held the air very poorly.

Cable Entrances—One of the difficulties resulting from the presence of groundwater practically up to curb level was that of creating the cable entrances, a factor peculiar to telephone buildings. Openings for 700 cable ducts to a maximum depth of 15 ft. below curb had to be provided by a method which would not flood the cellar.

This was accomplished by constructing the top section of the caissons through which the cables were to enter, with tunnel sections at each separate group of cables. Ledges, waterproofing laps and reinforcing steel ties were provided on the outside of the caissons for the connection of the duct tunnels at a later stage of the work. Each tunnel was blanked off on the inside face with a thin reinforced wall; after each duct tunnel was brought through the cofferdam and waterproofed, this wall was removed and the duct installation through the cofferdam was then completed.

Quantities and Organization—The quantities involved in this project were:

Caisson sinking	19,000 cu.yd.
General excavation	114,000 cu.yd.
Rock excavation	5,000 cu.yd.
Concrete	32,500 cu.yd.
Reinforcement	1,100 tons
Timber cross-lot bracing	1,340,000 ft. B. M.
Capacity of air compression plant	14,200 cu.ft. per min.
Total timber used on job	2,870,000 ft. B. M.
Volume of substructure space created	3,175,000 cu.ft.
Area of substructure floor space created	228,500 sq.ft.

The construction plant included 22 derricks and three complete concrete plants.

McKenzie, Voorhees & Gmelin were the architects for the building. Moran, Maurice & Proctor were the consulting engineers for the substructure design and supervision. Marc Eidlitz & Son were the general contractors, and the Foundation Co. executed the foundation work.

Leakage Tests on Steel Water Mains

SOME 12 miles of 42- to 60-in. steel water mains are being laid in Detroit under two contracts. When the specifications for these contracts were written, a question arose as to the amount of allowable leakage that would be permitted on acceptable work. After considerable discussion and reference to other specifications which were available, it was decided to place an arbitrary limit of 1 g.d. per ft. of pipe, regardless of the diameter. For 60-, 48- and 42-in. pipes this would be 88, 110 and 126 g.d. per in. diameter per mile of pipe.

RESULT OF TESTS FOR LEAKAGE OF LOCKBAR STEEL PIPE IN DETROIT

Diam. of Pipe, In.	Length of Pipe Tested, Miles	Leakage per Hour, Cu.Ft.	Leakage per In. of Diam. per Mile per Day, Gal.	Test Pressure, Lb. per Sq.In.
42	0.435	14.4	141	100
42	0.595	16.4	118	100
42	0.455	13.0	122	100
48	0.492	44.4	337	100*
48	0.429	11.8	103	100
48	0.390	11.0	106	100
48	0.110	2.9	109	100
48	0.282	2.6	34	100
60	0.385	19.8	83	100
60	0.156	4.1	78	100
60	0.366	10.4	85	100
60	0.146	2.6	53	100
60	0.337	9.8	87	100
60	0.281	5.9	63	100
60	0.275	1.0	11	100
60	0.209	2.0	23	100
60	0.318	7.4	70	100
60	0.202	0.5	7	100
60	0.240	6.0	75	100
60	0.250	6.9	82	100
60	0.253	7.1	84	100

* This particular section of pipe is improperly charged with leakage through a valve where it was impossible to measure the amount passing through the valve.

One of the contracts is nearly completed and the result of the tests is given in the accompanying table. The general spacing of riveted field joints was 30 ft.

The contract is being executed by the Mark R. Hanna Co. of Detroit, who purchased the pipe from the East Jersey Pipe Co. The inspection of the work and supervision of the leakage tests are under the immediate direction of Fred R. Sheridan, engineer of inspection and tests for the Department of Water Supply.

Pioneer Engineering in Deep-Water Salvage —Raising the Submarine S-51

A Brief Account of Open-Sea Diving Work at 132 Ft. Depth—Hull of Vessel Successfully Broken Loose From Clay Bottom—Underwater Repair Work—Tunneling With New Jetting Nozzle

ON JULY 9 a five months' struggle against the elements and against great technical obstacles came to a successful end when Lieut.-Commander Edward Ellsberg, of the Construction Corps, U. S. Navy, brought the hull of the rammed and sunk submarine S-51 to dry dock at the New York Navy Yard. The submarine had been raised after lying 132 ft. deep in the Atlantic Ocean east of Block Island for eight months, and, suspended by chain slings from a series of tank pontoons, had been brought through 20 miles of open sea and 130 miles of Long Island Sound and Hell Gate to the dock. The achievement was the product of precise calculations, inventive ingenuity, the skill of the best marine craftsmen, and a tremendous amount of dogged persistence. It proved the technical judgment and the courage of the men who early in the winter decided that the ship could be raised and who subsequently stuck to the work against all discouragements. Their plans finally succeeded at each stage of the undertaking—though at one point the resourcefulness of a machinist, who devised a new and completely successful under-water hydraulic excavator, was the vital factor in bringing about this success.

The story of how the campaign was fought through is Commander Ellsberg's own, set down here in impersonal form from his recital of the facts. It need only be prefaced with the reminder that on September 25, while engaged in maneuvers south of the Rhode Island coast, the S-51 was run down by the freight steamer "City of Rome" under way from Savannah to Cape Cod Canal, received a deep gash in her port side near the bow and sank almost immediately with practically all of her crew; that some days were spent in vain efforts to rescue those who might still be alive in the boat, hope being finally given up; and that thereupon the naval authorities decided that the boat could be raised and undertook the task.

During these first days of rescue attempt, two large derrick boats, of 250 tons combined lifting capacity, were sent out from New York to make an attempt to hoist the submarine to the surface. But these heavy vessels, unseaworthy in rough open water, had to wait five days in Point Judith Harbor for weather smooth enough to permit them to go out to the location of the wreck, 20 miles off shore, and then, after trying for half a day to lift the boat, were forced to give up the attempt as impossible and hurried back to safe harbor.

To come to Commander Ellsberg's story:

Conditions of the Work—It was necessary to raise a vessel weighing around 1,000 tons, lying on the bottom in water 132 ft. deep in the open ocean, out of sight of land in any direction. The bottom was a hard clay, practically a bed of shale, so hard that when the boat was sunk, going down bow first, it struck the bottom with a blow that buckled the shell in a series of wrinkles some 50 ft. back of the stem, in way of the torpedo compartment bulkhead. A wedge of the clay, brought up on the fluke of an anchor that had been lost in the early salvage operations and was later recovered, proved to be almost dry inside when broken open. Yet the ground was plastic enough so that under the weight of the ship it molded itself to the hull, which settled down into the bottom to a depth of some 7 ft. This hard and yet plastic bottom turned out to be one of the crucial elements of the problem.

It was already known that attempts to lift the ship by derricks were quite hopeless, at least out in the open sea, where at most two days out of seven were quiet enough for salvage work. The raising therefore had to be done either by providing sufficient internal buoyancy to cause the ship to float itself, or else by lifting the vessel by external buoyancy.

The physical condition of the ship was known, in detail, from minute inspections by divers. Of the five compartments into which the ship is divided by four transverse bulkheads, it was believed that three could be made watertight and thus would be available to provide internal buoyancy. The second compartment from the bow—the bunk room and battery space—was cut wide open by the prow of the colliding steamer; the torpedo compartment in the bow also could not be made tight. With the three undamaged compartments supplemented by submersible pontoons it would be possible to provide the necessary buoyancy for lifting the weight of the ship. The great unknown element was the suction effect of the bottom, the adhesion of the hull to the clay in which it was embedded.

Previous naval experience gave good reason for apprehending a large suction effect. In the recovery of torpedoes that had settled in clay bottom it has happened that a lifting line attached to the tail broke the body of the torpedo in two, so firmly did the suction of the bottom hold it down. In the case of the submarine, if its steel shell was everywhere in intimate contact with the clay, a large part of the weight of the overlying water might act to hold them together; and at the depth here involved this meant a resistance or anchorage of perhaps 6,000 to 8,000 tons.

Before the submarine could be lifted, then, it would be necessary to break the suction. There was reason for thinking that this could be done, as by applying a slow steady pull at one end with a view to gradually loosening the boat from its bed. Later, actual trial showed that this part of the undertaking was easier than anticipated. The work therefore required that buoyancy be provided to lift the total weight, that this buoyancy be applied in such a way as to overcome the suction of the bottom, and that there be a sufficient reserve buoyancy for all emergencies while towing the vessel 150 miles to the New York Navy Yard, the only available docking place. Accordingly, eight buoyancy tanks, each a cylinder 13x32 ft., were provided, capable of giving a net lift of 80 tons per tank or 640 tons in all. These tanks were built with heavy hawse-hole castings for sling chains, and with the necessary means for admitting and blowing out water. Together with

the three after compartments of the submarine (supplying 450 to 500 tons of buoyancy) they gave a total lifting power of about 1,100 tons.

Breaking the Suction—Before the equipment for lifting was ready, an attempt was made to break the suction of the bottom by using the undamaged submergence tanks of the submarine on one side for rolling the ship. The vessel as she lay on the bottom is roughly sketched in the adjoining cross-section, Fig. 3. The hull, slightly oval in shape, was lying with a list of about 13 deg. to port; the keel was embedded in the bottom, while the starboard bilge keel was clear. The body of the ship consisted of two concentric shells; the space between the two shells (and below the non-

men above, who knew the layout of the system from the construction plans. It must be borne in mind that the divers in performing these manipulations were deep inside the vessel after having entered by a narrow, tortuous passage, and that there was a chance of their being buried in the hull beyond rescue if the boat should suddenly roll over. Their work here called for steadfast courage. However, no accident occurred, and the tanks were successfully blown out.

The buoyancy lift on the port side as indicated was left on about a week, without noticeable effect. Then, over night, the ship rolled over until it had about the same list to starboard as formerly to port. The continued rolling moment must have brought pressure to

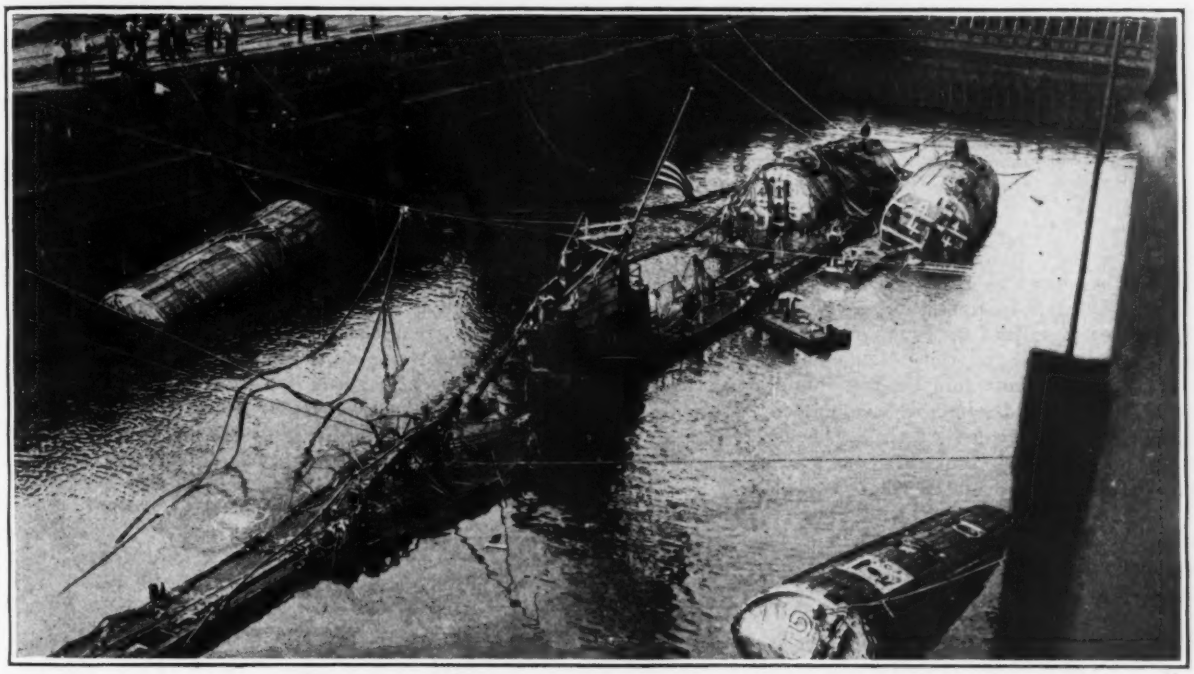


FIG. 1—SUBMARINE S-51 IN DRYDOCK AT BROOKLYN NAVY YARD

watertight upper portion of the outer structure) was subdivided into a number of separate tanks for use in submerging and emerging. Cylinders of high-pressure air in the ship, controlled by valve manifolds in the control room amidships, were the means of supplying air for emerging, while mechanically operated sea valves admitted water to submerge.

In spite of the collision and sinking, and months of submergence, the high-pressure air cylinders were found still intact, as was the piping and control bank except for certain pipes on the port side forward of the control room, which had been cut through in the collision and had emptied the cylinders to which they connected. The remaining high-pressure air proved to be sufficient for blowing out the intact port-side submersion tanks. The starboard tanks were left full, and thus a port-side lift of some 80 tons was applied, producing a righting moment of about 800 foot-tons in opposition to the list of the vessel.

Care and much courage were required for blowing out the tanks in this way. The divers, after orienting themselves in the control room and at the valve banks, had to turn specific plugs in specific banks of the group of manifolds, according to detail instructions from the

bear on the starboard edge of the clay bed, slowly crushing it down and progressively loosening the contact between hull and clay at the port side until the boat was free to roll over in obedience to the righting moment.

With this development the matter of the suction at the bottom disappeared from the problem. It was known that the boat could be broken loose whenever all was ready for the lifting.

Preparations for Lifting—Apart from providing the eight large tanks, two things had to be done: (1) Clear the water from the three rear compartments of the submarine in order to make these buoyant, and (2) Pass four pairs of chain slings under the hull for connection to the tanks. It turned out that each of these items involved almost interminable tasks and difficulties, which called for new expedients and methods almost daily.

Most of the work was done this spring, operations being resumed early in April. At the time of shutting down for the winter, in December, two large buoys had been placed by the lighthouse bureau, one on each side of the wreck, so that it could be found again. But when the working party arrived in April, it found the two buoys seven miles apart, neither one being near

the estimated position. No such evidences as oil patches or air bubbles, which had made the wreck easy to find in November, were now available, and dragging had to be resorted to, using a wire drag and grapnels. Fortunately, on the second day a small piece of rubber hose brought up by the grapnels centered the search on a small area; within the day the drags struck something, and a diver who went down landed squarely on the deck of the submarine.

Sealing the Compartments—As to the first of the two jobs; all of the doors between compartments were found open, the water having come in too suddenly when the collision occurred to give time for the least protective action. Various interconnecting valves were open. A number of pipe lines communicating between compartments and tanks and the outside had to be cut and blanked off. A butt joint in the outside shell plating near the rear of the motor compartment was leaking badly on its entire 5-ft. length. Several rivets were pulled loose and leaking near the stern, where an anchor had been dropped over the tiller room and had dented the shell. Overcoming these and many other difficulties so as to restore all possible internal buoyancy was a long and tedious campaign, of which, however, only one or two items can be mentioned here.

The leaking butt joint of the plating was calked very effectively by first filling the open space between the plate ends, about one-eighth inch wide, with improvised lead wool made by bunching up electrical fuse wire, and then split-calking the two plates. The leaking rivets over the tiller-room were sealed by replacing one rivet by an expanding lead plug whose upper end was then calked down, and by calking the heads of the other rivets very carefully. Large pipe lines that could not be controlled were cut by unbolting them at joints and making plate-iron blank flanges, marking and drilling them for the bolt holes, and bolting them in place with gaskets.

Grouting was resorted to for one or two special troubles. Two large automatic check valves on exhaust lines from the compartments had to have the valve flaps locked down, since as built they were free to open outward and thus would open under the internal air pressure which would be applied in blowing out the compartments. No feasible way of doing this could be found until the plan was conceived of grouting solid the space above the valve, thereby holding it down securely. Experiments were made with various cement and grout mixtures, and from these alumina cement was selected as giving the best assurance of working satisfactorily. Accordingly, a 1-in. pipe was screwed into the casing over the valve, carried up to the surface and to the deck of one of the salvage tenders, a height of nearly 150 ft., and cement grout was pumped down until the bonnet and pipe would take no more. After a day's setting the valve proved to be tight.

In all these and associated operations, much cutting, drilling and calking had to be done down in the depths. An oxy-hydrogen torch was developed which would cut steel successfully under water, and Commander Ellsberg, who developed it, made the first under-water cuts with it. Pneumatic drills, calking, chipping and riveting hammers were used with entire success, usually with about 150 lb. air pressure—giving about the same effective pressure as when working with 85 to 100-lb. air under ordinary conditions. Drilling was done in plates as thick as 1 in. The chief difficulty with the air tools was that as soon as they started operating they discharged a great cloud of bubbles in the water, so that the operator was quite unable to see his work but had to be guided by touch.

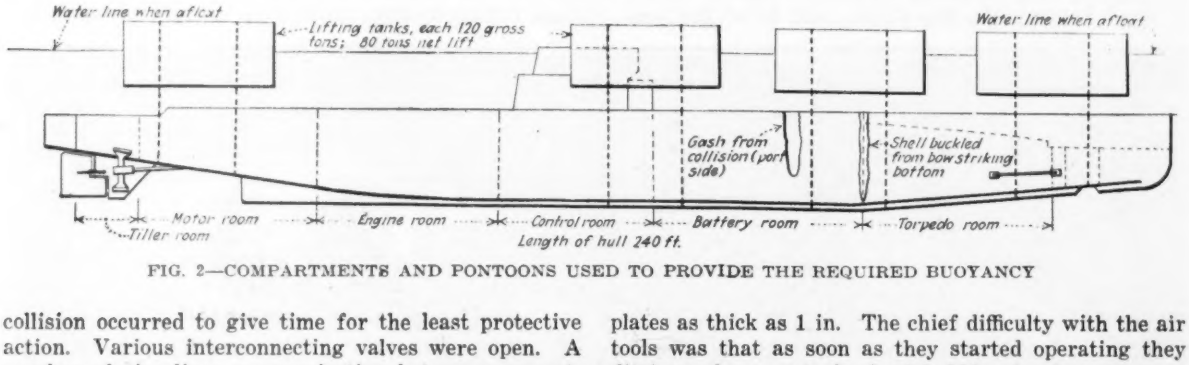


FIG. 2—COMPARTMENTS AND PONTOONS USED TO PROVIDE THE REQUIRED BUOYANCY

Tunneling Under the Hull—However difficult the necessary work within the hull of the ship, yet the placing of the pontoon slings was in certain respects the critical part of the work. The slings were to be of large stud-link anchor chain, of 2½-in. bar diameter. Three of the eight slings could be placed directly, the bow and stern parts of the ship being clear of the bottom; the other five, however, had to be passed through tunnels dug in the clay under the hull.

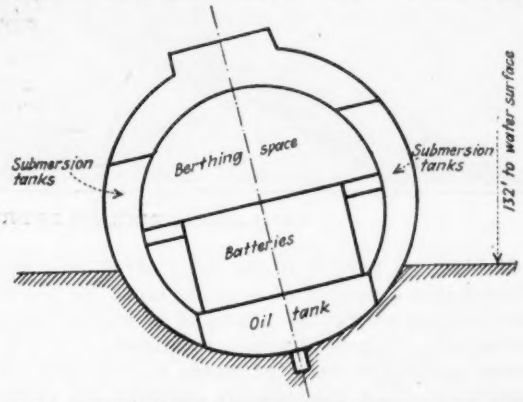


FIG. 3—SUBMARINE S-51 BEFORE RAISING—SKETCH CROSS-SECTION

The clay was both hard and sticky, and in the first tunneling operation, last December, divers working in shifts at a tunnel from one side only worked continuously (so far as weather permitted) for five weeks without being able to reach the keel. It was necessary to work with water jets. No progress could be made with shovels, as it took five minutes to dig a shovel in and fifteen minutes to pry the clay loose from the shovel blade. On the other hand when the diver tried a 2½-in. hose and nozzle the reaction of the 50-lb. jet promptly

shot him back many yards away from his work, while the hose writhed around in the water; his effective weight was hardly more than 60 lb., and he could not hold against the reaction. It was necessary to reduce the jet to 1 or 1½ in., and with this equipment, using 70-lb. pressure, the divers were able to dig in.

Work was infinitely slow under these conditions. The small stream had little digging power and its flow volume was too small to wash the loosened material back out of the hole. The tunnel tended to fill in behind the digger, so that sometimes after working in he had to turn around and wash his way out again. In addition, when after a few days of digging it was necessary to stop because of rough weather, the water refilled much of the completed tunnel.

In April, when work was resumed, two sets of divers working from opposite sides of the hull managed to tunnel their way down to the keel in two weeks of hard work; then, one of them shoving his foot through the final wall, the other succeeded in hitching a ⅜-in. line to it, and the first sling was provided for. The small line was used to pull a 1¼-in. manila rope through, this in turn pulled a 1-in. plow steel rope through, and this served for hauling in the heavy sling chain for attaching the pontoons.

In establishing this connection under the hull, the two divers made the second longest dive of the entire enterprise, working at full depth for 2½ hours—most of which was spent in trying to find the foot that had been pushed through and hitching the line to it.

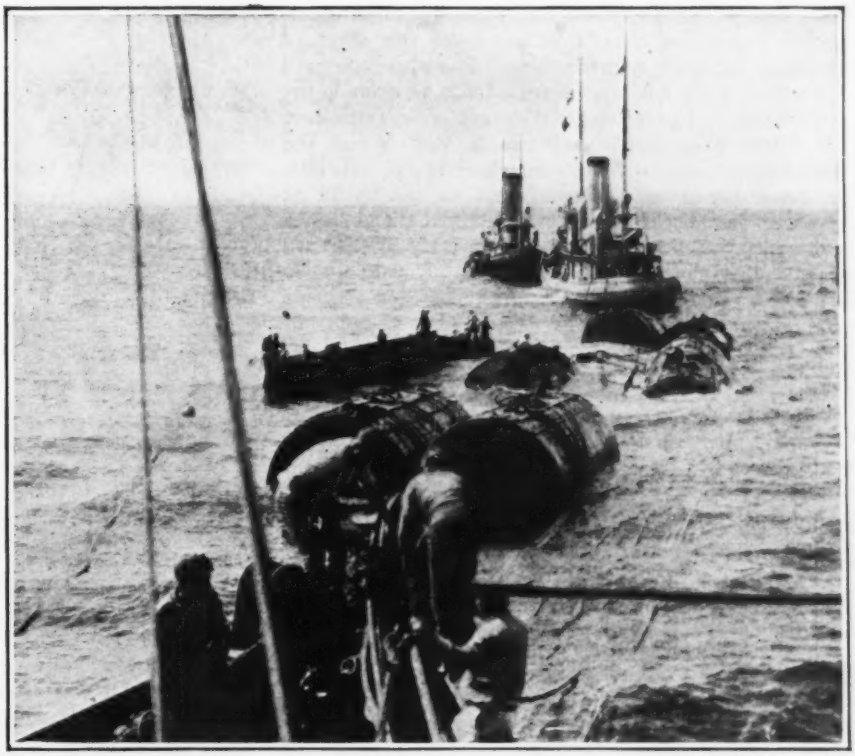


FIG. 4—ON THE WAY TO NEW YORK

A New Excavator Jet—It became evident that five tunnels would require a hopelessly long period of time, unless a quicker way of working could be found. Meantime, however, a machinist's mate, Waldern by name, assigned to running one of the engines on the salvage tender, conceived a plan for a nozzle that would have no jet reaction. In his idle time he made such a nozzle, and when completed asked that it be tried. It was tried, and it turned out to be a complete success.

This nozzle, to fit a 2½-in. hose, had a full size forward jet, and five smaller jets pointing backward at an angle to balance the forward reaction and at the same time to clear the debris out of the hole. With this nozzle, a diver had no difficulty in handling the jet, even at 150 to 200 lb. pressure, and a tunnel was put through in two days' work, excavating from one end only.

Diving Under High Air Pressure—All of the great amount of diving work done in carrying out these tedious operations had to be done under air pressures of 58 to 65 lb. per sq.in.—as compared with the 50-lb. pressure which is the extreme maximum for caisson foundation work, or 40-lb. (90-ft. depth) usually considered the greatest depth at which effective diving can be done.

Because of these unprecedently severe conditions, work was limited to one hour, and 1½ to 6 hrs. time was taken for decompression, either by raising the diver very slowly or by putting him in a recompression tank on board the tender after emerging. In spite of all precautions, many cases of bends occurred, but there were no fatalities, though one case was dangerously severe.

Submarine Returned to Port—After the successful placing of the sling chains the pontoon tanks were sunk, the chains were pulled through the hawse-holes in the tanks and secured with nickel steel toggles. Blowing out the tanks and the sealed compartments of the submarine, preceded by application of a lift one end first, to break the suction, brought the hull to the surface and made all ready for the tow to the Navy Yard. There were two almost disastrous interruptions, one occurring in the course of the trip to New York, when a pilot grounded the submarine on Man-o-War Reef, in the East River, south of Hell Gate; but aside from cutting one pair of the sling chains, causing the loss of two pontoons, and requiring the readjustment to the other pontoons to compensate, this produced nothing worse than half a day's delay, the hull being practically uninjured by the grounding.

Steel in Excellent Condition—When finally docked in the Navy Yard, the S-51 showed no injury to her framework and plating from the eight months' submersion, but appeared entirely sound except for her mechanical injuries and the deterioration of paint, battery plates and other perishable equipment. The steel of the structure was free from rust, and the vessel is fit for reconditioning.

Tests Show How Calcium Chloride Affects Concrete

Included Amounts Up to Five Per Cent Increase Strength of Concrete Slightly But Also Increase Shrinkage

By A. S. Levens
College of Engineering and Architecture, University of Minnesota, Minneapolis, Minn.

INVESTIGATIONS of the effect of calcium chloride on concrete have, thus far, dealt more with the surface application of the chemical as a curing agent than as an integral part of the mix. Tests have been made by the Bureau of Standards to reveal the effect of calcium chloride on reinforcement. Examinations have shown that while calcium chloride tends to corrode the reinforcement, the corrosion does not seem serious or of a nature progressive with age in cases where the reinforcement is completely embedded in the concrete. The tests described here were made by the writer at the Experimental Laboratory of the University of Minnesota under the supervision of Prof. M. B. Lagaard to determine the effect that calcium chloride (when used as an integral part of the mix) had upon concrete when (1) in tension, (2) in compression, and (3) to study the shrinkage effects.

Tension Tests—For these tests 510 briquets were prepared in 5 sets. For each set 17 batches, consisting

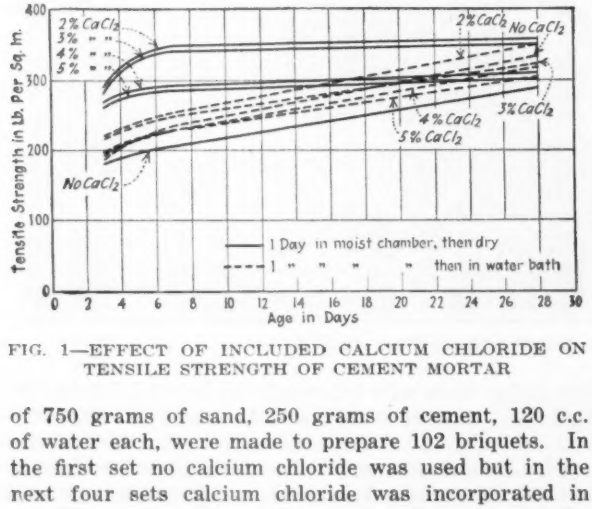


FIG. 1—EFFECT OF INCLUDED CALCIUM CHLORIDE ON TENSILE STRENGTH OF CEMENT MORTAR

of 750 grams of sand, 250 grams of cement, 120 c.c. of water each, were made to prepare 102 briquets. In the first set no calcium chloride was used but in the next four sets calcium chloride was incorporated in amounts, respectively, of 2, 3, 4 and 5 per cent by weight of cement. The age and conditions of storage and the tensile strengths are given in the accompanying table.

The strongest concrete was that which contained 2 per cent of calcium chloride and was cured one day in the moist chamber and then dry. The percentages of calcium chloride over 2 per cent tended to weaken the concrete.

Fig. 1 shows graphically the comparison in strengths of a mix having no calcium chloride with others containing varying percentages up to five. During the earlier periods (3 to 7 days) the increase in strength of the concrete containing 2 per cent calcium chloride was 40 per cent greater than that of plain concrete.

Fig. 2 shows that after 21 days the concrete containing calcium chloride (2 to 3 per cent) is stronger than concrete containing no calcium chloride, but the difference in strength is not very great.

Fig. 3 shows the difference in the texture obtained when calcium chloride is used. Note the difference between the two middle briquets (no calcium chloride) and the outer ones (2 per cent calcium chloride), otherwise mixed the same.

TENSILE STRENGTH OF MORTAR WITH INCLUDED Ca Cl$_2$

	Age in Days — Moist Chamber	Water Bath	Dry	Total	Set No.	Per Cent Calcium Chloride	*Tensile Strength (Lb. per Sq.In.)
Group 1	1	2	0	3	1	0	182
					2	2	220
					3	3	215
					4	4	198
					5	5	197
Group 2	1	6	0	7	1	0	234
					2	2	254
					3	3	248
					4	4	230
					5	5	227
Group 3	1	27	0	28	1	0	334
					2	2	351
					3	3	322
					4	4	317
					5	5	303
Group 4	1	0	2	3	1	0	180
					2	2	288
					3	3	282
					4	4	269
					5	5	262
Group 5	1	0	6	7	1	0	205
					2	2	348
					3	3	342
					4	4	293
					5	5	287
Group 6	1	0	27	28	1	0	290
					2	2	355
					3	3	352
					4	4	309
					5	5	305

*Each value in the last column represents the average of 17 briquets.

Compression Tests—In arriving at the consistency for the mix, it was attempted to approximate the consistency employed in practice. The sand and cement were mixed on the floor of the laboratory and water was then added until the mixture became as wet as could be handled on the floor. The amount of water used was determined by subtracting the residual water from the original quantity.

The flow table and slump tests revealed the following (this test made with a 1:3 mix):

Description of Mortar	Slump, In.	Flow Table, In. (Diam. of Mass.)
No calcium chloride	3.3	21
2 per cent calcium chloride	2.95	20

The material used in these tests was placed in two 6x12-in. cylinders and allowed to cure in the laboratory (temperature about 75 deg. F.) for 66 hours.

These cylinders were then broken and the following results obtained:

Description of Mortar	Age, Hours	Bearing Area, Sq.In.	Load, Lb.	Lb. Sq.In.
No. calcium chloride	66	28.27	13,400	474
2 per cent calcium chloride	66	28.27	27,600	976

Note the strength of the calcium chloride mortar. This shows an enormous increase in strength during a very short period. It is an increase of 106 per cent over the strength of plain mortar, that is, the calcium

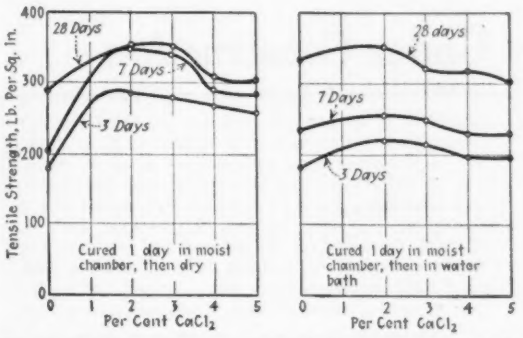


FIG. 2—TIME-STRENGTH CURVES OF CEMENT MORTAR WITH INCLUDED $CaCl_2$

chloride mortar made a cylinder 2.06 times as strong as the plain mortar cylinder.

The following tabulation shows the effect the calcium chloride had upon the concrete when in compression:

Method of Curing	Per Cent Calcium Chloride	Age, Days	Unit Load, Lb. per Sq.In
In water	0	3	900
	2	3	1,082
In air	0	3	856
	2	3	1,280
Air, 2 days water, 1 day	0	3	828
	2	3	1,112
In water	0	7	1,283
	2	7	1,377
In air	0	7	1,092
	2	7	1,746
Air, 6 days water, 1 day	0	7	831
	2	7	987

The strongest cylinders were the ones containing 2 per cent calcium chloride and cured in air for the entire period.

Shrinkage—Fig. 4 reveals the following facts:

1. At the end of three days the shrinkage of concrete containing 2 per cent calcium chloride is about 100 per cent greater than plain concrete.

2. At the end of seven days it is about 50 per cent greater than plain concrete.

3. At the end of fourteen days and thereafter it appears to be constant at about 85 per cent greater than plain concrete.

From this we may conclude that the use of calcium chloride increases the shrinkage and hastens the setting time. This increase continues throughout the entire test period.

Conclusions—A question which should arise in the minds of those who contemplate using calcium chloride as an integral part of the mix is "Does this great increase in shrinkage make the use of calcium chloride dangerous?"

FIG. 3—TEXTURE EFFECT OF INCLUDED CALCIUM CHLORIDE

Middle two have no calcium chloride, others have 2 per cent.

It will be noted from the curves showing the relation between tensile strengths and percentages of calcium chloride used that there is a downward tendency of the curves after 2 per cent calcium chloride. While there is a marked increase in strength using 2 per cent calcium chloride, the result of exceeding this amount tends rapidly to lessen the increase in strength over plain concrete, and with 5 per cent calcium chloride there is an actual decrease in strength as compared with no calcium chloride, in some cases.

It is a question, therefore, whether the increase in

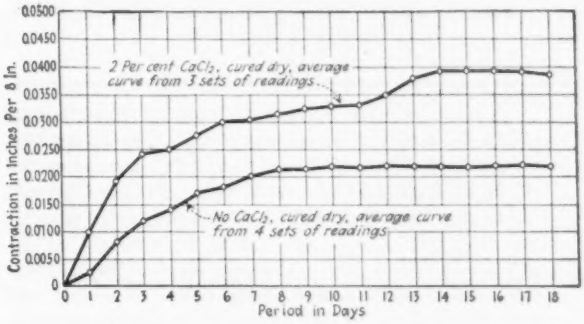

Contraction in Inches Per 8 In.
2 Per cent $CaCl_2$, cured dry, average curve from 3 sets of readings
No $CaCl_2$, cured dry, average curve from 4 sets of readings
Period in Days

FIG. 4—SHRINKAGE CHANGES AS CALCIUM CHLORIDE IS ADDED

strength obtained will justify the use of the chemical with the danger of uncertain results. The writer's attention has been brought to several instances where the value of calcium chloride was misunderstood, and where serious results have occurred due to its improper handling. Moreover, the increase in shrinkage places calcium chloride at a disadvantage since the action of shrinkage is to cause undue strains and cracking in a concrete structure.

The fact that shrinkage varies greatly under different conditions, such as variation in the mix, amount and kind of cement, age, curing conditions, type of aggregate, percentage of water, etc., is well known. Yet there seems to be no reason to doubt that the use of calcium chloride in the mix will cause increases in shrinkage in approximately the same degree in these different cases.

Acknowledgment is made for valuable suggestions and assistance of Prof. J. H. Parcel, Civil Engineering Department, University of Minnesota.

Hydro-Electric Power on Irrigation Projects

Hydro-electric power developed by water storage through the construction of dams on irrigation projects has been of value to the projects, according to a recent memorandum of the Department of the Interior. The total investment in thirteen federal reclamation power works is $6,077,649. The gross earnings of these power works for 1925 were $1,067,135. Net earnings were $442,619, or about 7 per cent in the total investment. To this satisfactory financial return are added benefits to the projects and to the farmers. Some of the benefits to the projects are reduction of construction and operating expenses by the use of power on dragline excavators in building and in cleaning out canals and drains and by the use of cheap power in pumping plants. Advantages to the settlers, beside the financial returns on power sold and the reduction in expenses, are power operation of farm machinery, electric lights in the home on several projects.

New York's Third Subway Under Construction

Timbering System Holding Street Surface and Structures Between Property Lines and Open Below for Power Shovels and Trucks Reaching Surface by Ramps

By Lazarus White
President Spencer, White & Prentis, Engineers and Contractors, New York

Continuing a series of articles on rapid-transit subway construction now in progress in New York, where a complete new network of lines is being added to those built in 1900-1904 and 1913-1918. The first article, June 17, 1926, p. 970, outlined the planning of the new system, the second, July 8, 1926, p. 60, described the development of construction methods, and the third article, July 22, 1926, p. 142, outlined the organization and methods of safeguarding street services and adjoining structures.

The contract for Section 3, Route 78 (Eighth Ave. Subway) 3,000 ft. long, provided for the excavation of 200,000 cu.yd. of which 20,000 yd. are estimated to be rock fill and the remainder sand and gravel. The upper end is in filled ground and above ground water level; the lower end is in original sandy gravel 6 ft. below ground water level. The original contract specified about 30,000 cu.yd. of concreting and 3,300 tons of steelwork. The total contract price is about $4,900,000 and the contract time is 42 months.

Eighth Ave. at this point is about 100 ft. wide and is lined with five-story tenement houses with stores at sidewalk level. The subway averages about 60 ft. in width, is standard four-track construction ("Engineering News-Record," June 17, 1926, p. 970) and there is a local station at 116th St. There were about 100 elevated railway columns to be underpinned, these columns being mostly on the sidewalks just inside the curb line. A second article will describe this underpinning in detail.—Editor.

THE contractors for this section of the Eighth Ave. subway felt that the changing economic situation and the developments of machinery since the construction of the dual subways, completed about 1920, necessitated different methods. During this interval the excavation of cellars, basements and foundations of large buildings had undergone a revolution. Derricks, skips, and horse-drawn trucks had been superseded by power shovels, motor trucks and ramps. Particularly, there had been a great development in the use of small crawler traction shovels, and a wonderful improvement in motor dump trucks. These trucks though weighing about six tons themselves can readily carry an additional load of about 5 cu.yd. of excavation up a 15 per cent grade. The flexibility of crawler shovel and motor truck outfits enables excavators to make phenomenal records in the removal of excavation from difficult and cramped locations.

Construction Plan—Realizing that steam, or gasoline shovels would be objectionable below ground, the contractors investigated the relative merits of shovels operated by air and electricity. The electric shovel was finally chosen because of its superior economy and flexibility. The section, being 3,000 ft. long, was divided into four parts, or headings, by two ramps at 114th St. and at 120th St. The ramps, Fig. 1, were constructed on a grade of about 15 per cent and at right angles to the prism of the subway, laid out so as to intersect the subway at subgrade. These two ramps were found to be entirely adequate for the work and useful in all stages of the construction. From each of them about 100,000 cu.yd. of excavation were removed in the period of six months, and a great deal of the structural materials of the subway such as concrete, steel, ducts, and timbers, were delivered by trucks through them. These ramps were considered to be less objectionable to the neighborhood than the old style of overhead gantries with their derricks, muck bins, etc.

After the use of the ramps was decided upon, the problem of supporting the street surface, trolley tracks, etc., in such a manner as to allow the operation of the shovels, trucks, etc., remained. The solution of this problem was about as difficult as could be encountered, as it was necessary to support two underground trolley tracks, numerous electrical subways for telephone and power cables, pipe lines, street and sidewalks in such a manner as to allow underpinning of the elevated railway. It was also considered essential for reasons of economy that the four tracks be excavated in one operation.

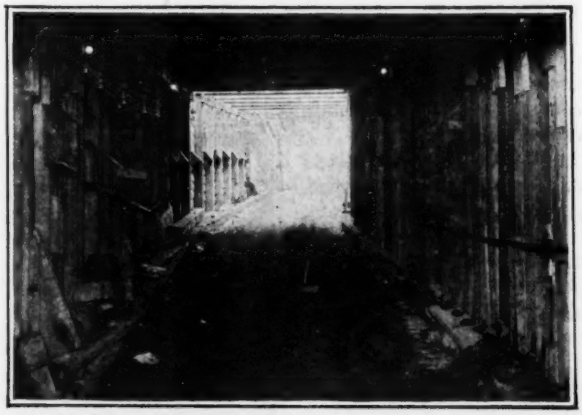


FIG. 1—RAMP FROM SUBWAY CUT TO STREET
Ramp is at right angles to cut and from a depth of 25 ft. ascends on a 15 per cent grade to street level. Photograph by courtesy Board of Transportation.

Supporting Street Structures—Referring to Fig. 2, it will be seen that the main supporting members are four longitudinal I-beams laid parallel to the track and to the curb. These beams were framed in pairs by means of 6x12-in. cross timbers resting on the lower flanges

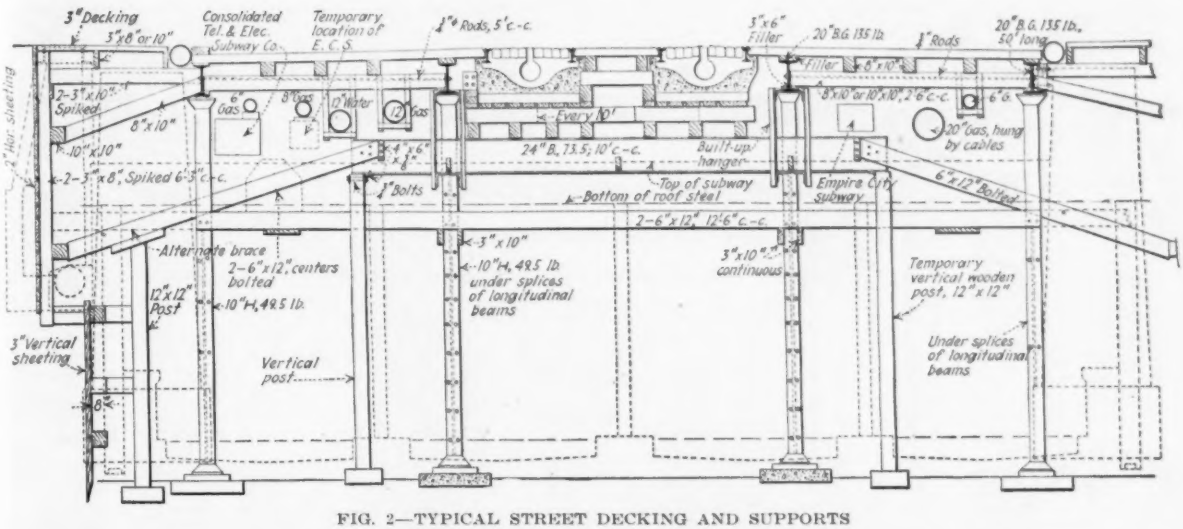


FIG. 2—TYPICAL STREET DECKING AND SUPPORTS

of the beams and by tie bolts at intervals, Fig. 3. Upon this framework the 6-in. deck is laid. The beams were laid as close as possible to the street surface so as not to interfere with the sub-surface structures below. The beams were lightly spliced longitudinally so as to hold their alignment. The problem of supporting the two trolley tracks and allowing sufficient space for the operation of the electric shovels was solved by placing transverse beams in a heading preceding the shovel. These beams were placed at intervals of 10 ft. and were posted to subgrade. These posts were fastened to the beams by means of angles so that the shovels could not readily displace them. The outer beams were directly supported by posts at 10-ft. intervals, Figs. 2 and 4.

Excavation Methods—In advance of the main excavation, largely to facilitate the underpinning of the elevated railroad columns, a trench was dug between the exterior beam and the outside of the subway. This trench was usually carried to a depth of about 12 ft., except at the elevated columns where it was carried to the depth of the base of the columns. The exterior sheeting of this trench was supported by braces directly to the outer beams, the upper brace horizontal and the lower one at an incline. The deck was made rigid by blocking between the inner beam and the concrete of the trolley tracks. The upper braces served a very important function, as they held the trolley tracks in line and enabled the excavation to proceed to a considerable depth without additional bracing. The shovel operating at subgrade excavated a complete section with the exception of a berm intentionally left at each side to decrease the amount of sheeting necessary. The berm was about 12 ft. wide by 12 ft. high. The ends of the transverse beams supporting the trolley tracks were braced to a lower ranger by an inclined strut consisting of two 6x12-in. timbers bolted together and to the end of the beam. Two angles attached to the beam served as abutments for the brace.

Four shovels (Fig. 4) were in operation for two shifts at the maximum and the maximum month's work was about 30,000 cu.yd., about thirty trucks being employed. The excavation of the cut was disposed of at Riverside Drive north of 104th St. When the headings met, the berm remaining at each side was removed by the shovels or by portable belt conveyors electrically

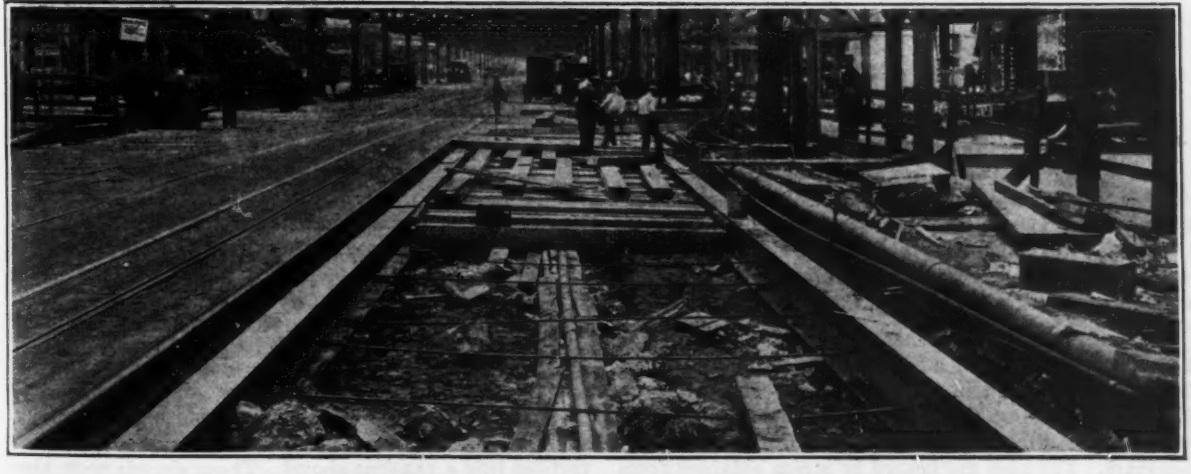


FIG. 3—LAYING DECK FOR STREET SURFACE LONGITUDINAL 20 AND 24-IN. I-beams 30 to 60 ft. long carry 6-in. planked roadway and by hangers cross-beams supporting street railway track.

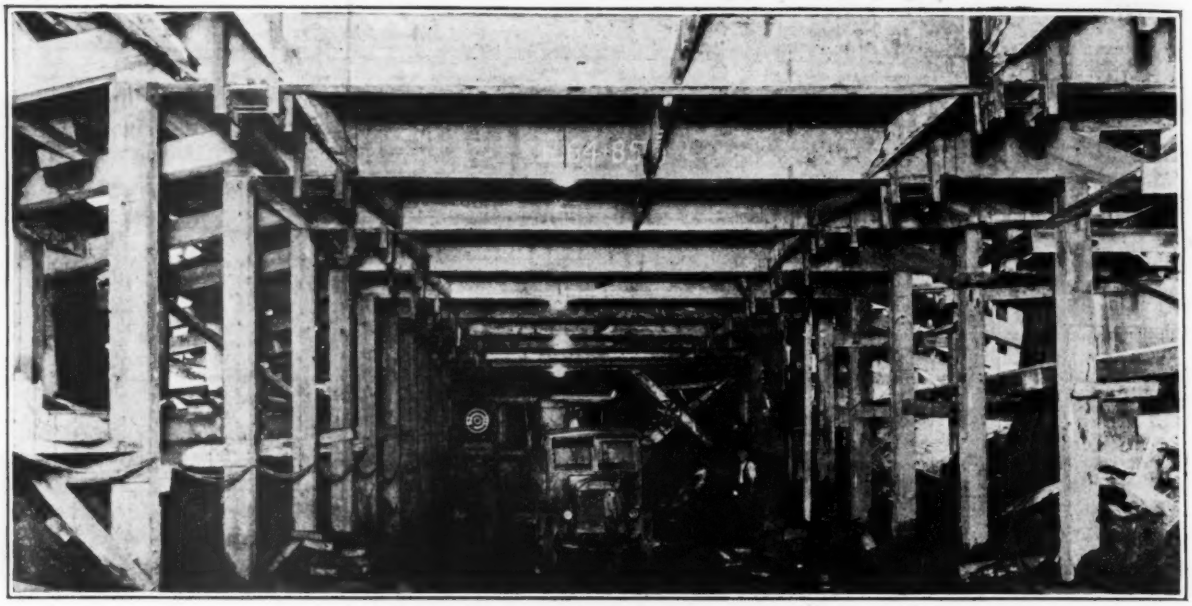


FIG. 4—TIMBERING AND CUT AT SUBGRADE
Note space for power shovel and trucks. Temporary steel posts shown in Fig. 2 not yet placed. Note hangers for transverse beams.

operated. The shovels were found to be best for rock fill and the conveyors for sand and gravel. As the berm was removed, additional sheeting was placed to subgrade, generally vertical sheeting, supported by rangers which were in turn supported by short struts extending to an intermediate post below the main brace. It was found that when the excavation was extended to subgrade the pressure at the bottom was not noticeable but that there was a considerable increase of pressure at the top braces, particularly at the uppermost brace. This was as expected, the bracing being designed for a computed total pressure obtained from observation by engineers experienced in this class of wark. This method of timbering not only conformed to experience but allowed freedom in the operation of the subway construction. Had the ordinary theories and methods of timbering been followed, the operation of the shovels and trucks would have been seriously hampered, if not impossible. Also the ease with which long and heavy H-beams can be secured enables the contractor to operate with a freedom which could not be realized on the old subways.

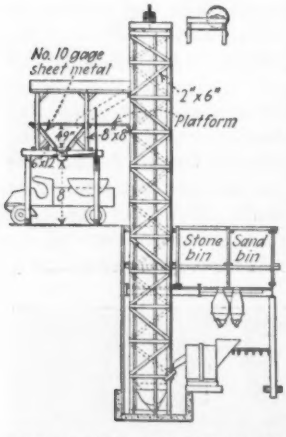


FIG. 5—ARRANGEMENT OF CONCRETE MIXING PLANT

Concreting Plant—Another feature of this work to be noted was the use of a central concrete mixing plant. This plant is shown in Figs. 5 and 6. The plant follows road building practice; it is completely enclosed and enables the concreting work to proceed in all weathers. The bins are heated by steam obtained from a boiler with an oil burner. This oil burner operates very satisfactorily. The concrete was transported by means of three trucks with roll-over bodies of about 1½ cu.yd. capacity. It may be noted that on the worst days of the past winter when about one foot of snow fell 200 batches of concrete were placed in the subway. The concrete plant is equipped with Butler proportioning hoppers, Fig. 6, which greatly facilitate the work and give an accurate mix. The forms used were mainly

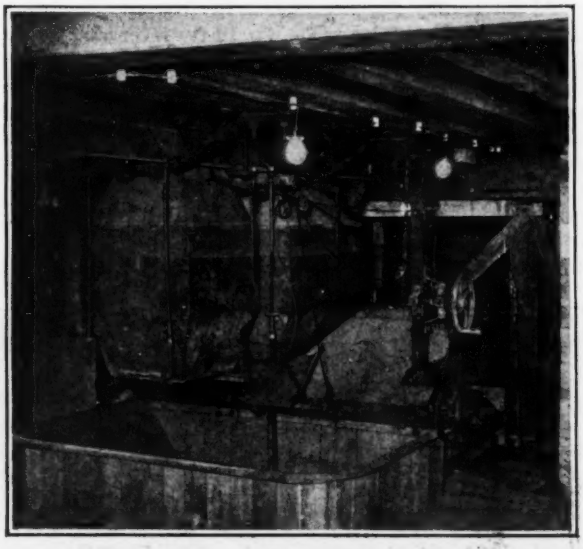


FIG. 6—MEASURING HOPPERS IN MIXING PLANT

Blaw-Knox forms of the type usually used in subway construction.

The shovels used on this work were Bucyrus 20-B model. These shovels are operated by two motors, one the main motor on the engine, and the other the crowding motor on the boom, the boom being specially short and of cast steel. This shovel is of a type convertible into a gasoline shovel. These shovels were also operated as cranes, being equipped with special booms for this purpose. They will work freely in a clear space

of about 30 ft. wide by 13 ft. high. A small crawler crane was also found to be very useful on this work, both in the excavation trenches and in the erection of steel below the deck.

A central compressor plant was installed at one end of the work and an air line laid on a bypass trestle. Indeed this contract was noteworthy for the amount of overhead gas bypassing necessary. The pipes were installed on overhead trestles and ranged in size from 30 in. to 4 in. It was found that plain end pipes with dresser couplings made a very efficient line. Several thousand feet of 20-in. line was laid on trestle within the period of a few weeks, and passed the first test without the retightening of a single bolt.

The work is being conducted under the supervision of the Board of Transportation—Robert Ridgway, chief engineer. Heyman & Goodman, Inc., is the contractor.

Keeping Salt Water Out of Lock-Controlled Waterways

Including Conclusions on Behavior of Salt Water in Fresh Water Canals Based on Studies at Lake Washington Canal, Seattle

By W. M. Meacham

Meacham & Babcock, Contractors, Seattle, Wash.

REASONS for not wanting salt water in lock-controlled waterways include the facts that it makes the water above the locks unfit for domestic purposes, injurious to boilers, useless for irrigation, good environment for teredos that are harmful to wooden structures, and unfit for fresh water fish. Salt is not removed by filtration or by any other artificial process. Therefore, where it is not wanted it must be kept out.

The author has worked for two years in conjunction with professors of the University of Washington on a series of tests to determine the reasons for salt in the Lake Washington Ship Canal at Seattle. The following deductions and conclusions are made with the results of these tests as a basis.

The locks at the entrance to the Lake Washington Canal form Lake Washington's only outlet. The canal is provided with a salt water drain consisting of a conduit that leads from a sump above the locks through the face of the dam. This drain did in a degree what it was designed to do but being small was inadequate and enough salt found its way into the water of Lake Union to make it unfit for use in steam boilers. A small quantity of salt water also passed into Lake Washington 8 miles above the lock. Fig. 1 shows a map of the canal.

Further study showed that the mixing of the salt water on the bottom of both the canal and Lake Union with the fresh water above it was increased by the propellers of tugs and ships. The mixing resulted in raising the center of gravity of the salt water on the bottom thereby increasing its store of energy. This increasing of volume helped both in driving the salt water up along the canal during periods of low water and in clearing it up again during periods of high water or when the lock culverts were opened and a current sufficient to balance or overcome the salt water head was attained.

Conclusions—In a broad waterway having practically no current, the sump for collecting and draining off the salt water should be located some distance away from the ship channel.

Deep sumps if they are full of fresh water stop the advance of the salt water for the length of time required to fill them with salt water.

The chemical diffusion upward of salt through a body

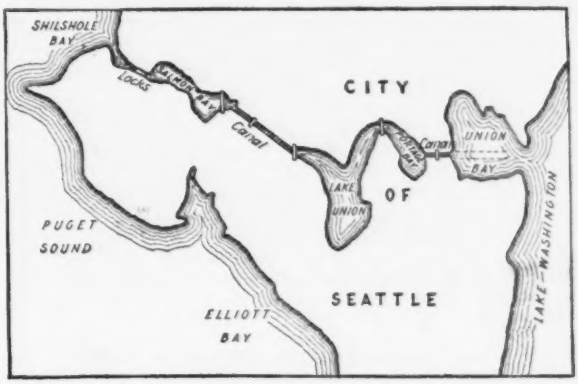


FIG. 1—MAP OF LAKE WASHINGTON CANAL AND SURROUNDING TERRITORY

of fresh water is so slow that it is negligible. However, mechanical diffusion which includes mixing due to convection currents, is a material factor.

Lower temperatures of salt over fresh water increases the specific gravity which in time helps to propel the salt water along the waterway.

The velocity of flow of the salt water should be kept low at all times where it can mix with fresh water.

A large volume of water should not be drawn from the sump at one point or from any small area, particularly when water is scarce. It was the experience at the Lake Washington Canal locks that the water from the salt water drain contained even less salt than the mean salt content of the water around its intake. The drain was drawing in fresh water from above it.

Finally, a sufficient volume of water either stored or continuously supplied from the watershed above is necessary for keeping salt water out of lock-controlled waterways.

Two Plans for Excluding Salt Water—One way of keeping salt water from going up fresh waterways is shown in Fig. 2. This consists of a siphon wall placed directly behind the spillway and a series of baffle walls or low dams across the channel in a sump above the lock. The tops of these walls are at the level of the bottom of the canal. This sump is shallower than the main sump and slopes toward it, so as to get salt water out at the bottom of the main channel as quickly as possible. The low baffle dams across the channel assist in doing this. The lower edge of the siphon wall should be well below the sill of the upper lock, say 10 ft. or more. Under the siphon wall a long narrow opening drawing off the correct amount of salt water per foot of its length will give the salt water head time enough to bring the salt water up to the wall thus preventing the drawing through of the fresh water from above. The water from the sump after passing under the siphon wall goes over the spillway in a regular and normal manner. In using such a siphon wall the upper lock culvert should draw water from behind the wall. This

salt siphoning spillway has been described as working with lock types as used on the Lake Washington Canal and the Panama Canal. These locks admit water from culverts through openings in the lower edge of the lock walls. A limited water supply is assumed with these siphon walls.

A second plan for keeping the salt from the canal

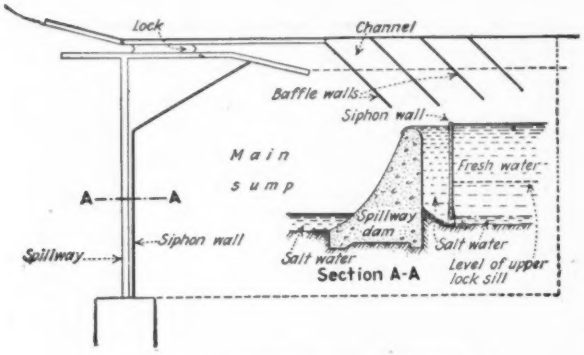


FIG. 2—A SALT WATER SIPHONING WALL
Wall placed directly behind spillway keeps salt water from passing up lock-controlled fresh waterways.

is illustrated in Fig. 3 which shows a salt clearing lock. This may also be used effectively in conjunction with the siphon wall. The inlet culvert is connected with fresh water while the outlet culvert empties into the salt water of the lower canal. Water entering the inlet culvert is discharged into the canal through a series of ducts leaving the inlet culvert on the under side and emptying into the locks just below the water level. By discharging at this point, the fresh water is placed on top of the salt water with as little mixing as possible. The ducts leave the inlet conduit at the bottom so that the salt water entering the lock when the lower lock gates are open will not contaminate the fresh water in the culvert, thereby increasing the amount of water required to be drawn off to freshen the locks.

In operation the valves in both the inlet and outlet

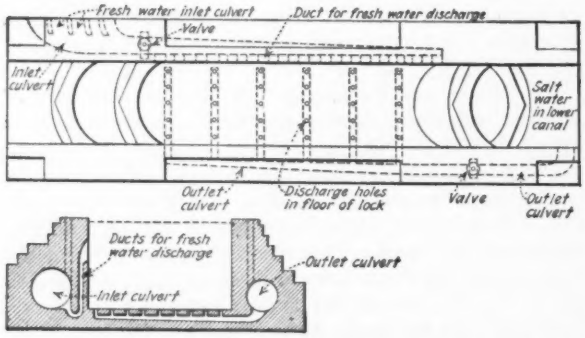


FIG. 3—SPECIAL LOCK FOR EXCLUDING SALT WATER FROM LOCK-CONTROLLED FRESH WATERWAYS

culverts are open allowing fresh water to enter the lock rapidly. By raising the level of the water in the lock, the head becomes greater than in the canal outside of the lock and creates a flow into the outlet culvert through the openings in the floor. This flow of the full capacity of the outlet culvert will increase as the head increases, continuing until the water in the lock has become fresh. The valve in the outlet culvert is then closed, the locks filled up to the higher level, and the upper lock gates opened.

A lock of this type would reduce the amount of salt water passed to a small quantity, making the work required of a siphoning spillway largely that of a safety device, for there would always remain the possibility of lockages being hurried or of a lockage being improperly handled, with the result that a lock full of salt water would be emptied into the higher level.

Crossing Agreement Between City and Railroad Held Binding

THE United States Supreme Court, before it adjourned, ruled in the case of the Missouri, Kansas & Texas Railway Co. vs. the State of Oklahoma and the city of McAlester, Okla., that a contract entered into by the railroad company and the city of South McAlester, now a part of McAlester, by which the city agreed to pay the cost of opening a certain street across the right-of-way of the railroad does not constitute a surrender of police power on the part of the city and that the enforcement of an order of the State Corporation Commission upon the railroad to construct the crossing would "impair the obligations of the contract in violation of the Constitution of the United States."

In 1901, in order to improve the railroad crossing situation in the city of South McAlester, the city and railroad entered into an agreement whereby the railroad granted certain rights-of-way across its property to the city and agreed to build certain crossings and to pay a portion of the cost of others. The agreement stipulated that in the case of Comanche Ave., the city would bear the cost of constructing an undercrossing when required.

In 1921 the city applied to the State Corporation Commission for an order requiring the railroad company to provide an undercrossing at Comanche Ave. This the commission did, specifying that the city and railroad agree upon a division of the cost. The railroad petitioned the Supreme Court of the State to set aside the order as a violation of contract. The court decided against the railroad on the ground that the commission has full jurisdiction over all highways where they cross railways and that it had authority to order the crossing built and to assess the cost against the city and railroad; that the agreement between the railroad and city constituted a surrender of police power on the part of the city and hence was void.

The Supreme Court, in reversing this decision, states that the agreement does not limit the number of crossings which the city may require and so is not a surrender of eminent domain, that the enforcement of the decision would deprive the railroad of its property without due process of law in violation of the Constitution of the United States.

New Railway Project in Manchuria

A survey is being made of a railway line running from the Omuhsien through Ninguta or Ninganhsien to Sansin in Kirin Province, Manchuria, according to a report to the Department of Commerce. The cost of the line including all construction work, etc., is not to exceed $40,000 per kilometer. The work must start by Jan. 1, 1927, and be finished by January, 1930, or within three years.

Suggested Improvement in Macadam Road Design

Granular Sub-Base, Stone Shoulder Drains, Concrete or Bituminous Curbs to Stop Spreading and Give Edge Strength

BY A. T. GOLDBECK
Director, Bureau of Engineering, National Crushed Stone Association, Washington, D. C.

Condensed from an article in the Journal of the National Crushed Stone Association, Washington, D. C.

IN CONSIDERING the macadam road, I think it essential that we rely not on cut and try methods of improvement, but rather should we take steps which have been developed as a result of engineering analysis. Under the term "macadam type" I include broken stone base with a water-bound macadam top, with or without a bituminous surface treatment, a bituminous macadam or a bituminous concrete top.

To design any structure, the engineer must make an analysis of the forces and destroying agencies which act. Let us first consider the forces to which a macadam road is actually subjected, and see how these forces are resisted.

Forces Due to a Wheel Load—Several years ago by means of special soil pressure measuring apparatus, the distribution of pressures under a broken stone slab was measured by the U. S. Bureau of Public Roads. A curve of the general nature shown in Fig. 1 was obtained. Notice that

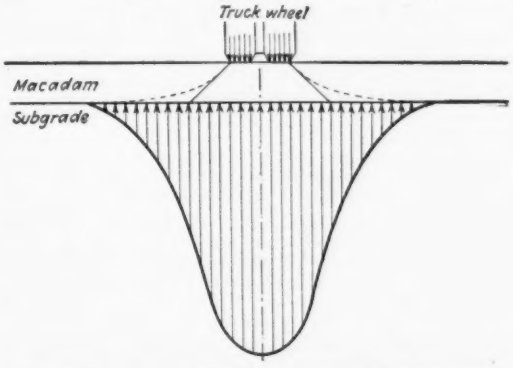


FIG. 1—TYPICAL PRESSURE DISTRIBUTION CURVE OF WHEEL LOAD ON BROKEN STONE SLAB

the vertical pressure on the subgrade is greatest under the wheel and tapers down to zero at a small distance away from the wheel.

Influence of Compaction—If the stone were loosely laid on the subgrade, the load would be spread, very largely by virtue of the overlapping of the individual stones upon those below. This is crudely illustrated in Fig. 2, in which the short vertical lines at the contact points indicate vertical forces only acting in the stones. Here the load is spread over a comparatively small area of the subgrade. On the other hand suppose the layer of stone is well compacted and keyed. In this case as shown in Fig. 3, a considerable amount of horizontal pressure is developed on each stone and hence considerable vertical friction exists at each point of vertical contact of one stone against its neighbor. Consequently when a load is applied on a given stone it is transmitted to the stones below not only by virtue of the fact that it rests on them directly, but also because the stones immediately adjacent to it carry part of the load which is transmitted to them because of the high frictional resistance between the adjacent stones. Also because of the high lateral restraint of the stones it seems entirely probable that considerable arch action might be developed under wheel loads. It follows, therefore, that the more compact the layer of stone, the wider will be the distribution of the wheel load over the subgrade. The following statement can be set down as one of great importance in the proper construction of a macadam base or roadway:

> I. Thorough rolling and keying should be used so that the individual stones shall be compacted tightly into position. High lateral restraint is thereby developed and wheel loads are better distributed over the subgrade.

Effect of Load at Edge—We have considered thus far a load placed at an intermediate position in the pavement. This is a very favorable position for distributing load to the subgrade, for here the surfacing material is wedged tightly into position by the surrounding compacted mass of stone. At the sides of the road, however, the stone is held laterally only by the earth shoulders and in the spring of the year this restraint is almost zero. Undoubtedly then, one of the weak points of the macadam road is the lack of sufficient lateral restraint for the stone at the sides and here an improvement in design might well be attempted.

Effect of Road Thickness—Obviously if the wheel load be placed directly on the subgrade, the full load is supported over the area of contact of the wheel with the subgrade and the subgrade pressure under the wheel is then of the greatest intensity possible. If a layer of stone is used the

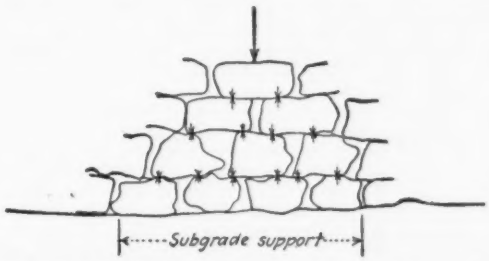


FIG. 2—VERTICAL FORCES ONLY TRANSMITTED BY LOOSELY LAID STONE

pressures are spread over a wider area on the subgrade and consequently the intensity of pressure is decreased.

> II. The thicker the layer, the lower is the intensity of wheel load pressure on the subgrade.

Influence of the Subgrade—The subgrade plays a vital part in effecting the stability of a broken stone surfacing. If the pressure transmitted be too great, the subgrade will yield under the load and immediately high shearing stress will result in the road surfacing which will destroy its mechanical bond and render it much more susceptible to destruction from subsequent loads. Moreover, considerable yielding of the subgrade under a wheel load will result in plastic flow of the subgrade material and this causes a pushing up of the surfacing on each side of the load. If the load is placed near the side of the road, plastic flow will take place with greater ease toward the side of the road and under such adverse subgrade conditions, broken stone surfaces develop depressions near the side and the extreme edges might be raised and moved out toward the shoulders.

> III. A broken stone road requires excellent subgrade support.

In general, it might be said that the extreme characteristics of subgrade soils are:

Bad Soils	Good Soils
(a) Extremely fine state of subdivision (as in clays)	(a) Coarse, granular texture
(b) High moisture capacity	(b) Low moisture capacity
(c) Extreme plasticity	(c) Non-plastic when wet
(d) Difficulty of drainage	(d) Easily drained
(e) Low bearing value	(e) High bearing value
(f) High volume change	(f) Low volume change

It is highly important that the above subgrade characteristics be fully considered and—

> IV. The design of a broken stone road must be suited to the particular subgrade upon which it is supported.

Moisture in Subgrade—If the percentage of moisture could be kept sufficiently low probably all soils would fur-

nish adequate subgrade support. We might set it down as an important principle that—

V. It is highly important that suitable measures be taken to drain away excess moisture from the subgrade.

Improving Bad Subgrades—If granular soils furnish good support, and plastic soils poor support, it will be quite possible to improve a bad soil by the admixture of enough good material. The use of an admixture of sand with a clay soil to form a sand-clay road surfacing is a typical example of this procedure and such a surfacing forms an excellent foundation for a broken stone road. The use of a layer of granular material such as fine stone screenings, cinders, fine sand or similar material would also be beneficial for several reasons:

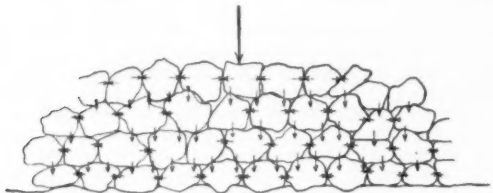


FIG. 3—COMPACTED STONE TRANSMITS BOTH VERTICAL AND LATERAL FORCES

(1) Because such a layer would serve as so much more effective thickness for distributing the load to the subgrade.

(2) Because such a layer would greatly aid in preventing the upward intrusion of clay into the broken stone layer, thereby preventing its full effective depth from being decreased through lubrication of the stone by the clay.

(3) Drainage of the upper layers of the subgrade would be facilitated and the accumulation of capillary moisture in the upper layer would be lessened.

Admixtures of certain materials which might improve the physical characteristics of plastic soils are also not without possibility and are under experiment at the present time by several agencies. A few states have been using a granular sub-base under their pavement surfaces with very good results.

VI. A sub-base of granular material having characteristics listed above for good soils would be beneficial under macadam roads on bad subgrades.

Studies in Design—Studies have been undertaken in the cross-section design of bituminous macadam roads to see if the above objects might not be accomplished without an appreciable increase in cost over that of present standard construction.

For the purpose of comparison a so-called "standard cross-section" will be used. This consists of an 18-ft. bituminous macadam pavement having a total uniform thickness of 11 in. with a 3-in. bituminous macadam top, laid on a 8-in. base, constructed in two courses, 5 in. and 3 in. in thickness, respectively. This approximates one of the present state standard cross-sections and with this "standard" as a basis it will be interesting to consider the various forms of cross-section proposed in order to study the probable value of the suggested changes in design. Admittedly, the estimates of costs of these cross-sections are apt to be faulty but are probably close enough for purposes of general comparison. The first design, Fig. 4 has as its main features:

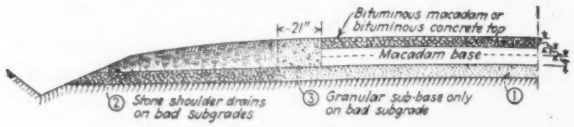

21"
Bituminous macadam or bituminous concrete top
Macadam base
② Stone shoulder drains on bad subgrades
③ Granular sub-base only on bad subgrade
①

FIG. 4—PROPOSED IMPROVED DESIGN FOR MACADAM ROADS

Features: (1) Use of sub-base granular materials to (a) Reduce intensity of pressure on sub-grade. (b) Serve as cut-off layer to prevent intrusion of clay into macadam. (c) Reduce capillary moisture in subgrade. (d) Drain surface of subgrade and prevent accumulation of free water. (2) Use of stone shoulder drains to (a) Stabilize side of macadam against lateral displacement. (b) Prevent breaking down of edges of macadam thus making for greater width. (c) Provide a light colored border thus aiding in night driving. (3) Use of concrete curb to (a) Drain sub-base and subgrade.

(1) The use of a sub-base of granular material consisting of clean bank-run gravel, stone screenings, cinders and like materials which will serve: (a) To reduce the intensity of pressure on the subgrade; (b) to act as a shut-off layer to prevent the intrusion of clay upward into the macadam base; (c) to reduce the capillary moisture in the subgrade; (d) to drain the surface of the subgrade and prevent the accumulation of free water.

(2) In connection with this layer (see Fig. 4), wide and frequently spaced stone shoulder drains should be used, for otherwise a reservoir will be created which might actually cause increased softness of the subgrade.

(3) To strengthen the outer edges of the pavement, concrete curbs are provided 11 in. in thickness and 21 in. in width. These dimensions were calculated so that this cross-section would have about the same beam resistance as the concrete shoulders used successfully in the state of Maryland. Such a curb stabilizes the macadam against lateral displacement, prevents the breaking down of the edges of the bituminous surfacing, thus making for greater effective width, and provides a light colored border which has been found to be of advantage in night driving. This section has been reduced from 11 in. to 10 in. in thickness at the center for it is believed there is much more likelihood of the subgrade having higher supporting value at the center than at the sides during critical periods of the year, and moreover, at the center, the load is more widely distributed over the subgrade than near the edges of the macadam. It is estimated that this type of cross-section will cost approximately $5,500 a mile more than the standard cross-section. This additional expenditure is warranted only if a saving in annual maintenance cost of 5 per cent of $5,500 or $275 is effected thereby. Although such a section should require less maintenance to keep the edges in good condition, it becomes a question as to whether or not this saving warrants the extra expense for concrete curbs. It also becomes a question as to how favorably the annual cost of a cross-section of this type would compare with that of other types of pavements suitable for similar conditions of traffic. It is probable that this section would be more expensive in first cost than a suitable section of concrete. The behavior of concrete curbs under severe freezing conditions is also open to some question.

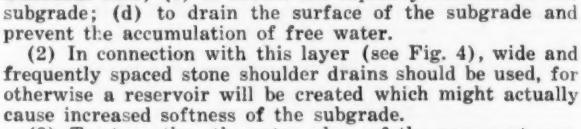


FIG. 5—IMPROVED MACADAM ROAD DESIGN SUGGESTED BY H. M. SHARP

Features: (1) Stepped construction at edge better to distribute subgrade pressures. (2) French drains where needed to promote dry subgrade.

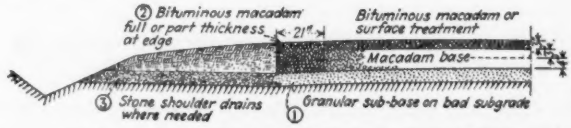

② Bituminous macadam full or part thickness at edge
21"
Bituminous macadam or surface treatment
Macadam base
③ Stone shoulder drains where needed
Granular sub-base on bad subgrade
①

FIG. 6—PROPOSED IMPROVED DESIGN FOR MACADAM ROADS

Features: (1) Granular sub-base, (2) bituminous macadam at edges of road using hard bituminous binder throughout depth to increase both vertical and lateral strength at edges, (3) stone shoulder drains to drain sub-base.

In Fig. 5, proposed by H. M. Sharp, formerly chief engineer of the Ohio State Highway Department, it will be noted that the first and second base courses are each laid with an extension of 6 in. beyond the course above. Reference to the curves of distribution of pressures, shown in Fig. 1 will show that such a design is logical for it provides extra bearing area for the load when placed at the edge of the pavement. In this type of construction, wherever necessary, French drains should be used to help insure a

dry subgrade. This cross-section is likewise decreased in thickness 1 in. at the center as compared with the standard cross-section. It costs approximately $500 per mile more than the standard cross-section and, in comparison, would have to show a saving in yearly cost of 5 per cent of $500 or $25 per mile. There should be less breaking down at the edges of a pavement of this type as compared with the standard type and such a section would very likely be a more economical section than the standard cross-section; also, because of its comparatively low first cost it should compare very favorably with competing types of pavements.

In Fig. 6 the essential feature is the use of penetration macadam edges, either in the second base course or throughout the whole depth of the pavement, extending over a width of 21 in. from the sides. The center thickness has been decreased to 10 in. instead of 11 in. as in the standard section. In the case of a bad subgrade a granular sub-base and stone shoulder drains should likewise be provided. Figuring on the basis of a full depth penetration of bituminous material at the sides at the rate of 5 gal. per sq.yd. for the full depth, this section costs approximately $800 per mile more than the standard section. If the extra thickness of bituminous macadam is extended only through the second base course such a section would cost approximately $200 more than the standard section. It would seem that considerable benefit might result through the stiffening effect of the bituminous material applied either through the full depth or part depth at the edges of the road.

Variations in this design can well be worked out to very good advantage and in Fig. 7 such a design, proposed by Carl L. Van Voorhis, chief engineer of the Ohio Crushed Stone Association, is shown. Note that in this design use is made of thickened and extended edges in the base course, and the bituminous penetration is extended through the

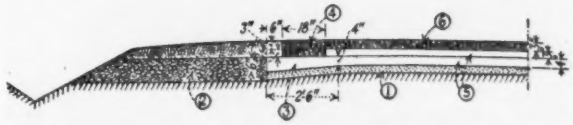


FIG. 7—MODIFICATION OF DESIGN FIG. 6 PROPOSED BY CARL L. VAN VOORHIS

Features: (1) Granular sub-base on bad subgrades, (2) stone shoulder drains where needed, (3) thickened and extended base, (4) bituminous macadam edges in second base course, (5) waterbound macadam base, (6) bituminous macadam or surface treated top.

second base course at the sides. This section would cost approximately $100 more than the standard, but has features which recommend it as an improved design.

In Fig. 8 is shown a type of construction which has been included in these studies as a section which offers interesting possibilities. Notwithstanding its very radical features it should be well worth building experimentally. The proposal is to construct the various courses of broken stone as they would normally be constructed with the exception that the first and second base courses would be filled with screenings only over part width instead of full width, thus leaving a narrow strip of unfilled stone at the sides. After rolling of the three courses is completed, it is proposed to pour the side strips not quite full of calcium chloride-accelerated portland cement grout in the proportions of 1:2, thus forming a grouted-in-place concealed concrete curb of the cross-section shown. Later the bituminous macadam course would be poured and finished in the usual manner. It is felt that such a curb would greatly add to the vertical and horizontal stability of the pavement at the edge. In time it probably would crack transversely at frequent intervals and would then act in practically the same way as large hand placed stones held firmly in position. Considerably increased support of the pavement edges should result both vertically and laterally. The cost of the grouting would be, roughly, $1,300 per mile, and the net increase in the cost of this section over the standard cross-section would be approximately $700, a yearly increased cost of $35 which would have to be saved through decreased maintenance. Where bad subgrades are encountered, a granular sub-base and stone shoulder drains should be provided also.

The use of portland cement grout along the edges has some disadvantages, chief among which are: (1) the necessity for having extra equipment on the job, such as a grout mixer and its appurtenances; (2) the uncertainty of the desired degree of penetration of the grout; and (3) the necessity of subjecting the grouted edge to the weight of the roller during the rolling of the bituminous macadam top.

A more practical and more economical method than the above has been suggested by R. W. Coburn, construction engineer of the Massachusetts Highway Department. It consists of using a dry mixture of portland cement and sand as the filling material in the stone base course or courses and depending either upon artificially or naturally applied moisture to set up the cement. Unquestionably such a method would add to the strength of the edges of a

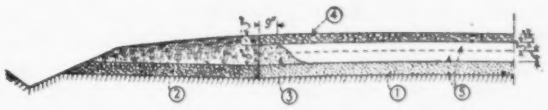


FIG. 8—MACADAM ROAD SECTION PROPOSED FOR EXPERIMENTS

Features: (1) Fine granular sub-base on bad subgrades, (2) stone shoulder drains where required, (3) portland cement grouted curb to strengthen edges, formed by filling voids either with liquid grout or dry cement-sand filler, (4) bituminous macadam top, (5) waterbound macadam base.

bituminous macadam pavement and the expenses would not be unreasonable, probably not over $1,000 per mile. Taking into account the decreased cost of this section due to the use of less stone in the center the net increase would then be about $400. This idea of using a dry filler of cement and sand or cement and stone screenings along the edge is most certainly worthy of a practical trial.

All of these sections should require less maintenance expense because they are strengthened along the edges where the present design is weakest. Generally side breakage is progressive and is due to the lack of support offered by the base. With all of these sections, decreased pressure intensity on the subgrade at the edges should result because of a better distribution of the loads, and in Figs. 4 and 8 lateral restraint is likewise provided. Also the use of shoulder drains and a granular sub-base under all sections on bad subgrades should increase the load resisting value of the subgrade.

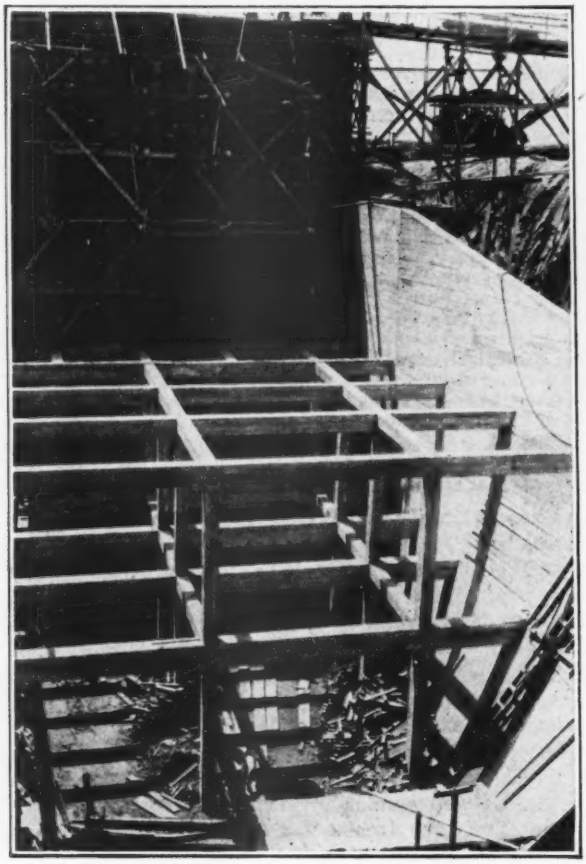
Water-Works Men Still at Sea on Income Tax

A resolution of thanks to the American Water Works Association for the part it took in getting Congress to relieve employees of municipally-owned water-works from paying federal income taxes accrued prior to 1925 was sent to the recent Buffalo convention of the association by the Detroit Municipal Employees' Club through George H. Fenkell of that city. The resolution aroused considerable discussion as to the status of claims for taxes for 1925 and subsequent years. The government has withdrawn its appeal from the decision of the U. S. District Court for Michigan that employees of the Detroit municipally-owned street railway are exempt from the income tax because street railways are a municipal rather than a private function. Some district collectors are not attempting to collect the 1925 tax from water-works men but the understanding is that the Internal Revenue authorities in Washington still hold that employees of municipally-owned water-works are liable for the tax because furnishing a public water supply is a private rather than a municipal function. W. W. Brush, deputy chief engineer, New York City Department of Water Supply, expressed the opinion at the convention that the question will remain in doubt until settled by the United States Supreme Court. Either an individual or a municipality could carry a case through, but it would be preferable, Mr. Brush said, for a city to do so.

Irrigation District Served by Series of Pumping Plants

Return Seepage in River Makes Storage Unnecessary and Automatic Motor Control Reduces Attendance to Minimum

THE Banta-Carbona Irrigation District includes about 15,000 acres of land located on the west side of the San Joaquin Valley in California at an elevation of 50 to 175 ft. above the river. The streams draining into this side of the valley have no sustained flow and there are no suitable reservoir sites for controlling the erratic discharge accompanying heavy rains. The lift from wells is high and the quality of well water is often poor. However, the success of irrigated areas on the west side of the river has been demonstrated by the success of several large projects which lift river water



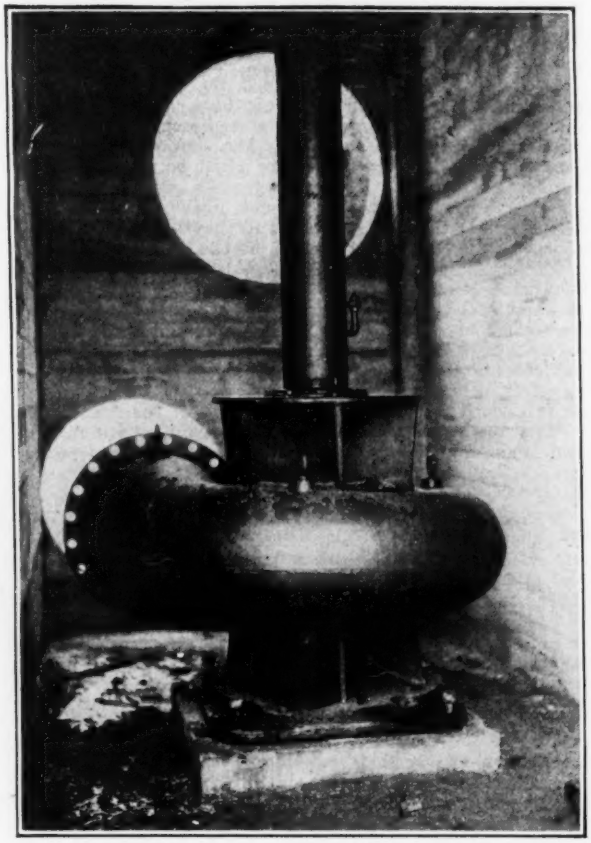
CONSTRUCTION VIEW OF INTAKE AT POWER HOUSE 1

Cut here was 42 ft. deep in sand and clay, requiring concrete posts and beams to support retaining wall. Canal bottom 13 ft. below water level.

up the slopes in a series of pumping plants. This was the plan adopted for the Banta-Carbona district except that in this case a larger number of pumping units was employed and water was lifted to a higher level than heretofore.

The water supply is taken from the San Joaquin River at a point where the return flow from irrigated areas above maintains a discharge sufficient to supply the needs of the district even in periods when all the tributaries are dry. The water supply is therefore assured without storage works. Claim to this water has been established by the purchase of an old canal system which had early rights and by license from the State Division of Water Rights.

The canal system is constructed almost entirely in



PUMP-SETTING 35 FT. BELOW MOTOR FLOOR LEVEL

This pump, operated by 200-hp. motor, delivers 40 sec.-ft.

cuts. All of the successive lifts start with a slight cut and run into depths at the pump house which range from 25 ft. in the upper levels to a maximum of 42 ft. at pump house 1. Partial fills at the lower ends of the upper canals were avoided because the system can be very easily increased in carrying capacity when the canals are all in cuts. Moreover, the deep cuts will do much to prevent accumulation of subsoil water after irrigation.

The first or intake canal has a bottom width of 25 ft. with slopes as steep as they will stand which is about 1¼ to 1. This canal was dredged with two floating dredges which moved a total of about 300,000 cu.yd. The lift from the bottom of the canal to the top of the spoil bank greatly exceeded the lift that could be made by a dredge floating at river level. So the canal was dammed at the river end and water pumped into it to maintain water level at about El. 25. Floating at this height a dredge using a 160-ft. boom could excavate the deepest cut and deposit material on the bank without rehandling. In the deeper parts of the cut the vertical distance from cut bottom to top of spoil bank exceeded 60 ft. The average cost of this excavation was approximately 20c. per cu.yd.

Concrete lining 2½ in. thick was used in the bottoms and sides of the lower cuts. Where lining was used the slope was made 1 to 1, and the concrete was carried to a height of 3.9 ft. above the canal bottom. The grade selected was 0.0005 which with a coefficient of roughness of 0.15 gave a velocity of 3.77 ft. per second.

The lining was contracted at 7½c. per sq.ft., the district furnishing the cement. This made the total cost to the district approximately 9½c. per sq.ft. Since the same contractor who did the excavation also had the lining job it is believed that some of the cost of bank sloping is not included in these figures.

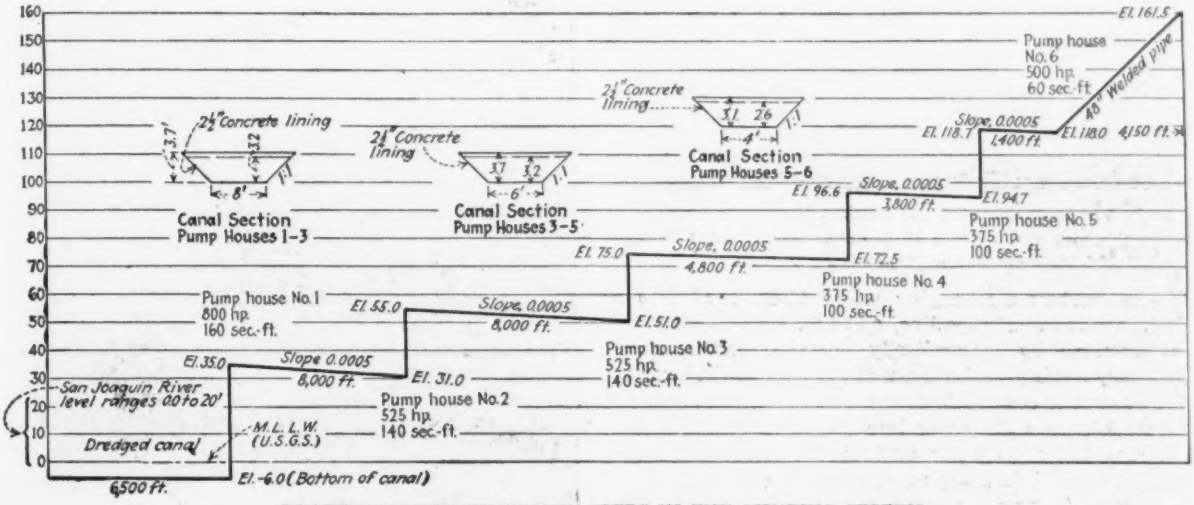
The slope of the ground between pump houses 5 and 6 is on a grade of 80 ft. to the mile. Here a line of 48-in. electrically welded steel pipe was used instead of the concrete-lined ditch. The pipe is ⅜ in. thick and has welded joints every 30 ft.

Four lateral canals running on contours at El. 77, 100, 122 and 171 feed sublaterals which deliver to each quarter section holding. The contour laterals have a bed width of 6 ft. and 1½ to 1 slopes, and are built to carry 5½ ft. of water. With this large canal capacity it is possible to store water during the night, enabling large heads to be delivered in daylight hours. Power rates are so fixed that night power consumption does not figure in the demand rate and under this system the maximum pumping is done at night in the off-peak hours.

The irrigation district buys current from the power company at 60,000 volts and has constructed its own substations and 2,200-volt distributing system between plants. This distribution system, the figures show, saves the district about $8,000 a year. Owing to the lower power rate for larger consumption the average cost of power per acre was the same for a lift of 175 ft. as for 125 ft. In other words, increasing the lift 50 ft. did not increase the average pumping cost per acre.

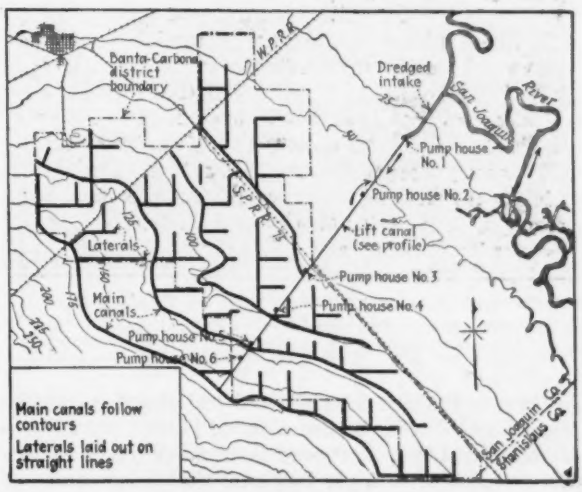
At the point of diversion the river level fluctuates from 1 ft. below sea level to 20 ft. above. It was therefore decided to use vertical pumps and to place the motors well above high-water level. To eliminate any form of suction pipe a double-suction submerged-type pump with convolute casing was selected which has the advantage of being self-priming. Only the most general conditions were specified at the outset and various machinery manufacturers were invited to submit competitive layouts of pumping equipment. Bids were received from seven pump manufacturers, only one of which had previously built submerged vertical pumps of large size. A number of the proposals were for horizontal pumps tipped on end with no change in design of intake. When the competition narrowed down to two manufacturers on the question of price, final decision was made on a basis of efficiency.

Plant 1 contains three 24-in. and two 20-in. pumps, driven by 100- and 200-hp. motors, the latter being



PROFILE OF SIX SUCCESSIVE STEPS IN THE PUMPING SYSTEM

mounted 35 ft. above the pumps beyond the reach of even the highest floods. The discharge is through 30- and 36-in. pipes, equipped with flap valves, into the concrete-lined canal above. This plant is the only one housed in a concrete building, the other structures being



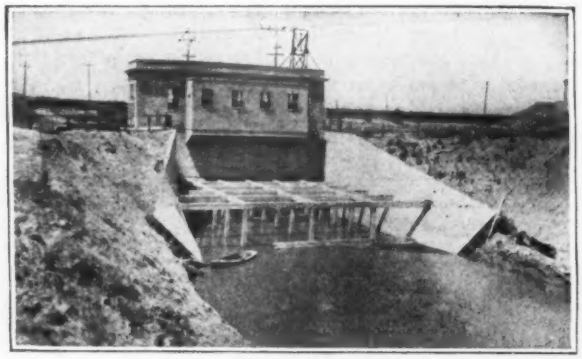
LOCATION OF CANALS AND LATERALS

steel frames on concrete foundations with corrugated iron sides and roofs.

Pump houses 2, 3, 4 and 5 are equipped with 20- and 24-in. pumps with a lift of 22 ft., driven by 75- and

150-hp. motors. Up to this point the motors are automatically controlled by float switches both above and below, and time-delay relays are provided for all motors but one so that the motors automatically come on the line, one at a time, following any shutdown in power.

Plant 6 is equipped with two 20-in. pumps driven by

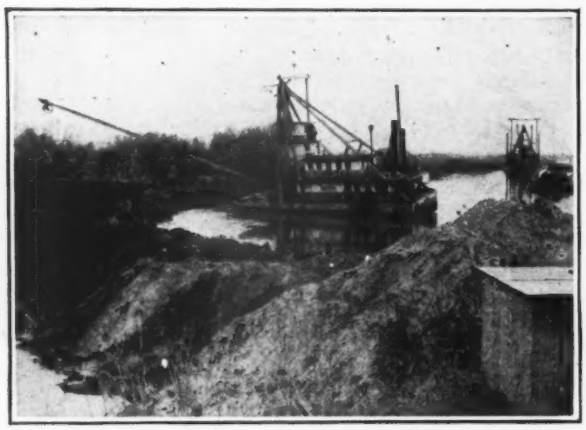


INTAKE SIDE OF POWER HOUSE 1

In this view the water is 17 ft. deep. Depths range from 6 to 22 ft.

250-hp. motors discharging under 55-ft. head into a 48-in. welded steel pipe line, 4,150 ft. long. This plant is protected by hydraulically operated valves, automatically closing on shutdown of the pumps. The use of the automatic control devices for starting and stopping in accordance with water level and power supply has eliminated about 80 per cent of the attendance ordinarily required in pumping systems of this size.

Because in new irrigated districts it is frequently necessary to change sublaterals and the structures used



TEMPORARY DAM AT RIVER END OF INTAKE CANAL

Canal water level was pumped up to 25 ft. above river level during construction. This enabled dredges to raise material 70 ft. in one lift. River level shown in left foreground.

in them as the land is subdivided and placed in cultivation, it was decided to use redwood lumber for all sublateral structures. Redwood lasts many years in this vicinity and, even in the long run, timber structures of this sort were found more economical than concrete.

The system was designed and laid out under the general direction of Thomas H. Means, consulting engineer. W. D. Harrington is chief engineer of the Banta-Carbona Irrigation District. Pumping equipment was supplied by the Byron Jackson Pump Manufacturing Co.

Electric Track Brake for Gravity Switching in France

Sliding Skates Placed on the Rails by Power Devices Check Freight Cars Entering Classification Tracks

FOR the control of cars by means of track brakes in gravity switching, an interesting development is the extensive application of electrically-operated skates or track shoes in the large freight yards of the Nord Railway at Lille, France. In such switching, it has

FIG. 1—FRENCH TRACK BRAKE FOR FREIGHT YARDS

Skate on right-hand rail engages car wheel until pulled aside by the diverging guard rail. Note cable and sheaves at left.

been general practice to use skates which are placed on the rails by yard men, but the practice requires a large number of men, while it is only partially effective and is a dangerous operation. Following out the idea of a power-operated shoe, as suggested by Mr. Javary, director of operation, the present system was devised and put in trial service. It has been patented by Mr. Deloison and Mr. Deyon, of the Lille freight terminals.

In this system, as shown in Figs. 1 and 2, and described in *Engineering News-Record* of Oct. 9, 1924, p. 598, a guard rail is placed outside one of the running rails so as to form a groove or channel. At its farther end this rail is bent outward and a short rail is placed beside it, so that the groove diverges from the track. A skate or shoe riding on the main and guard rails has a stop block or wheel stop on the top, while on the under side is a lug fitting within the groove and thus holding the skate in place upon the rails. The end of the skate is feather edged, so that a wheel will ride up onto it and engage the stop block. In Fig. 1, the skate is a few feet in advance of the approaching car.

In the lower part of the space between the two rails is a block sliding freely on bars or guides riveted to the rail webs. This block is attached to an endless cable operated by a motor-driven drum at the entering

end of the guard rail, as shown in Fig. 2. On the upper side of the block are lugs high enough to engage the lower part of the sliding skate, but the skate and block are not connected.

As a car approaches the track brake, the operator in a tower presses a push-button and causes the motor-driven cable and block to push the skate along the groove. At the end of its travel, current is reversed automatically and the cable draws back the block to its normal position, leaving the skate in place. The car wheel riding up on the skate strikes the stop block and causes the skate to slide along the rail, thus checking the velocity by the sliding friction. When the groove diverges from the track, Fig. 1, the shoe is guided away from under the wheel, the car then proceeding freely at reduced speed. The operation of this device is noted briefly in the 1926 report of the Yards

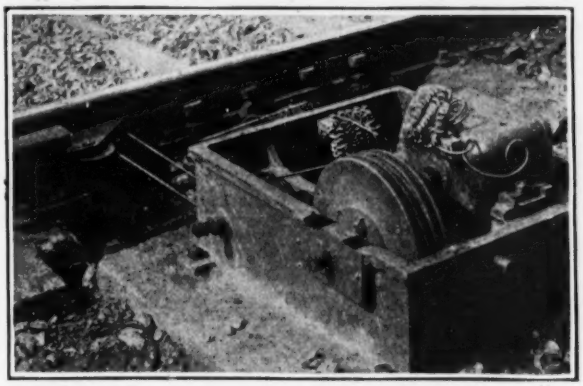


FIG. 2—MOTOR-OPERATED DRUM FOR TRACK BRAKE

and Terminals committee of the American Railway Engineering Association (Bulletin 282).

From the yard plan, Fig. 3, it will be seen that this track brake is applied to the six ladder tracks and ten of the classification tracks, the two groups being controlled from separate towers. In this way the cars may be checked at two points as they enter the classification yard. The brakes on the ladder tracks are used to check heavy cars or cuts of cars, as well as cars running at such speed as to overtake preceding cars. The maximum travel of the skates is 66 ft. for those at the ladder tracks and 98 ft. for those at the body tracks. In view of the satisfactory results obtained with this first installation, it is intended to equip all the body tracks of the classification yard, making a total of 43 track brakes, as shown in Fig. 3.

Gravity operation at the Lille yard is effected without the use of a hump. In the receiving yard, the tracks are on a descending grade of 0.5 to 0.6 per cent, followed by a starting grade of 1.8 per cent for 263 ft. along the ladder tracks, approaching the switch tower from the right. On this grade the cars or cuts of cars are uncoupled from the train which is being pushed slowly along one of the ladder tracks. From a point at the right of the switch tower a grade of 0.8 per cent extends for 328 ft. to the first track brakes; this is followed by a grade of 0.5 per cent along the classification ladder tracks and into the body tracks to just beyond the second group of track brakes. With these grades the cars do not exceed a speed of 10 m.p.h. when they reach the first track brakes on the classification ladder. However, it must be remembered that the equipment consists mainly of four-wheel cars of 10 to 15 or 20 tons capacity, with only occasional six-wheel cars or double-truck cars. All yard switches are electrically operated from the tower on a bridge spanning the ladder tracks.

An improvement introduced in the latest installation provides for varying the length of travel of the track skate to meet the varying conditions of cars requiring greater or lesser amount of braking. For this purpose a control lever in the brake tower is made to move along an arc or sector graduated for different lengths

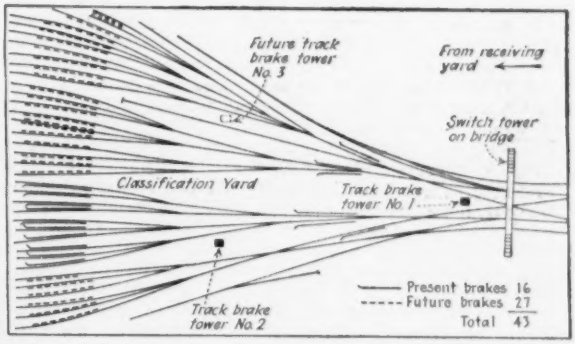


FIG. 3—TRACK BRAKES IN YARD AT LILLE, FRANCE

of travel. Thus, if the operator judges that a travel of 12 meters (39.36 ft.) is required to check an approaching car, he swings the lever over to the "12" mark on the sector and then presses the push-button, thus starting the motor of the track brake. The latter action also releases the lever, which is returned to its normal or zero position by a spring. On reaching this position, the current is first cut off and the drum then reversed, drawing back the sliding block and leaving the skate on the track at 12 meters from the point where it runs clear of the car wheel. The period of travel of the lever in returning from "12" to "0," and consequently the period of operation of the electric motor, is so arranged as to correspond to a travel of 12 meters by the shoe.

French Standard Track Design

For new track construction on its heavy-traffic lines the Nord Railway of France is using 92-lb. T-rails with screw spikes, heavy rail anchors and an American type of splice, but without tie-plates. In tunnels a 110-lb. rail is used. The rails are 59 ft. long, laid with a cant or inclination of 1 on 20, on 30 oak ties spaced 16⅞-in. to 24⅜-in. c. to c., each rail being secured by three screw spikes. They are laid with square or even joints on the closely spaced ties and spliced with the Weber joint of bridge type, having four bolts in 25-in. bars and bridge plate or base plate. Unusual provision to prevent creeping includes two bars spiked across the ends of the five middle ties and an anchor bolted to the middle of each rail. These anchors resemble Z-section splice bars about 8 in long, each secured to the web of the rail by two bolts and having a vertical leg which extends below the rail and bears against the face of a tie. Slag and stone ballast of ¾- to 2½-in. size is 12 to 14 in. deep under the ties and shouldered out level with their tops for a width of about 18 in. On clay roadbed a 12-in. layer of sand or cinders is laid as sub-ballast.

Letters to the Editor

A FORUM FOR DISCUSSION OF VIEWS OF ENGINEERS AND CONTRACTORS

Chicago Municipal Engineers' Strike

Sir—Your editorial "From Gesture to Blow," in *Engineering News-Record* of July 15, p. 86, castigates members of Local 14 and its predecessor, the Engineering Employees' Association first, for the so-called gesture of 1925, then for the blow of 1926. It would be infinitely stronger if the facts were more clearly understood. The so-called blow was not directed against the engineering profession, or the public of Chicago or the city council, except as the latter permits itself, by its own rules, to be dominated by a minority in all matters of appropriations. The council has 50 members; the finance committee, 18. All appropriations require a two-thirds vote for approval, or 34 votes with all members of the council present and voting.

The very first vote on increasing the pay of the engineers (full council not present) gave a majority for the increase but 14 members of the finance committee voted no and defeated the proposal. After fourteen hours of deadlock the finance committee gave in to the majority. Of the 37 councilmen who stayed to the end on June 30-July 1, 35 voted for the salary increase. On July 8, the council, or those present, unanimously passed a resolution fixing the basis for the salary increase. The city's finance staff, with the concurrence of the union's committee, will prepare the necessary ordinances to make the increase effective.

You are not to be criticised for following out the lines of training, environment, and so-called professional ethics, but you must be convinced, as are all other engineers, that something had to be done to ameliorate the condition of the technical engineers. Organizations of engineers have sprung into existence; some have survived, the majority have passed into innocuous desuetude, none has been able to accomplish anything to protect the engineer in his position or to advance his financial interests. He has depended on his individual capacity and has paid the penalty. He has been maintained, whether designedly or not, as a buffer between capital on the one hand and labor on the other; receiving all blows from each and none of the remunerations of either.

This is particularly true of the municipal service. He has been laid off, demoted, subjected to frivolous charges, and removed from service without recourse. Some thus charged have fought back and carried their battles into the courts, and after battling the great financial power of the municipality have successfully won the battle for reinstatement. Of these, the writer is perhaps an outstanding example, having carried a lawsuit through every court in the state, taking fourteen years to do it, and having been compelled to win this lawsuit seven different times before the delays of the courts could be overcome, reinstatement accomplished and judgment obtained.

Having failed repeatedly in working through organizations (and perhaps it may be pertinent to name a few; the Civil Service League, the Western Society of Engineers, American Association of Engineers and Engineering Employees' Association) the engineers finally turned to union labor. Not because they had a particular desire to do it, but because they were compelled of very necessity to seek the only protection which seemed possible; that of the methods which have proved successful throughout the ages where working men are concerned. For it cannot be said the engineer is any less a working man because he is an engineer. He may not work with his hand, but he works with his brain, or he may work with both hands and brain; but in any event he works harder. Could any city administration or any private party treat employees as many of us have been treated if employees had behind them a strong union battling for their individual and collective interests? It is my judgment that the action of the engineers in this case is but an illustration of what an intelligently led organization with the right affiliations can do.

Your editorial states: "We have seen no evidence that, prior to the strike, the engineers' campaign for increased pay was thoroughly planned and executed for the purpose of winning not only the council but also public support." Doubtless the writer of that editorial has not been in close touch with the facts, or this statement could not be made. It is an admitted fact on all hands that the public and the majority of the city council favored and were willing to pay engineers and architects adequate compensation. And this, after a campaign lasting five or six years, in which your journal played a part. Our campaign had covered every issue and received the support of every engineering organization and association in Chicago, but all to no account. You also state: "We have also persistently stood for due compensation for services rendered, but not through the union route." Why not? You admit and advocate organization for engineers for their individual and collective advancement, but when you find there is no advancement otherwise, you still do not approve the "union route."

Is it not strange that intelligent, educated engineers should be the last of all the professions and trades to join in an effective method of obtaining adequate compensation and working conditions? It is true that they are the last to organize, thanks to their education as individualists, their environment as individualists, and their closeness to the top, receiving no benefits therefor except that of a buffer between capital and labor, if that may be considered a benefit.

Approximately 99 per cent of the employees of the city of Chicago in an engineering grade are now enrolled as active members of Local 14, Technical Engineers, Architects and Draftsmen Union. Of the remaining 1 per cent, several are not eligible to be members of the union. The total number of men affected is 573.

P. C. McARDLE,
Engineer of Tests, Bureau of Engineering,
Department of Public Works.

Chicago, Ill.,
July 30, 1926.

A Rock Tunneling Problem

Sir—*Engineering News-Record* of June 17 in outlining New York's third subway system presented a graphic picture of the vastness of this new venture of the city. The bird's-eye view of the junction of the Sixth and Eighth Ave. trunk lines with the 53rd St. line to Queens, shown on the insert sheet of that issue, exhibits more complicated twining and weaving of tunnels than has ever been attempted in a like space. If to this picture had been added the crowded subways, the streets with their service substructures, the high buildings, and the elevated railway occupying 53rd St., the unusual problems involved in the proposed construction would have been even more fully brought before the reader's eye. It invites careful consideration of best construction methods.

Borings along 53rd St. show that the subway here will traverse mica schist of average quality. Manhattan schist consists of layers and varies abruptly from hard gneiss to soft, decomposed rock, with the ledge sometimes broken up into loose rock. Making a very large excavation contemplated in the plans for the subway (see sketch *A* in the attached figure) and lining it with concrete molded in place would undoubtedly require much timbering and pumping, and would involve construction hazards that it seems desirable to avoid. On the other hand, if the structure here were built as two separate single-track tubes, one driven after the other and lined with precast lining, giving immediate support to the rock and cutting off the water as soon as grouted, the difficulties would be avoided.

That precast lining has had successful use is brought out in Lauchli's "Tunneling" (1915), which describes the use of concrete block masonry in lining numerous important railway rock tunnels in Europe, including the famous Simplon tunnel: "Such blocks possess the advantage of being manufactured in advance, and when used they have already reached a high compressive strength. They can be placed more rapidly than dressed stone or brick masonry, and as the compressive strength of artificial or concrete blocks is more uniform than that of stone or brickwork, a smaller factor of safety can be used." Thus it is seen that many years ago concrete block lining superseded both brickwork and ordinary concrete in some of the greatest European tunnels. Unfortunately, this is not commonly known to engineers in this country; in fact the writer's own knowledge of it was derived from the book mentioned, some years after he had originated and used interlocking

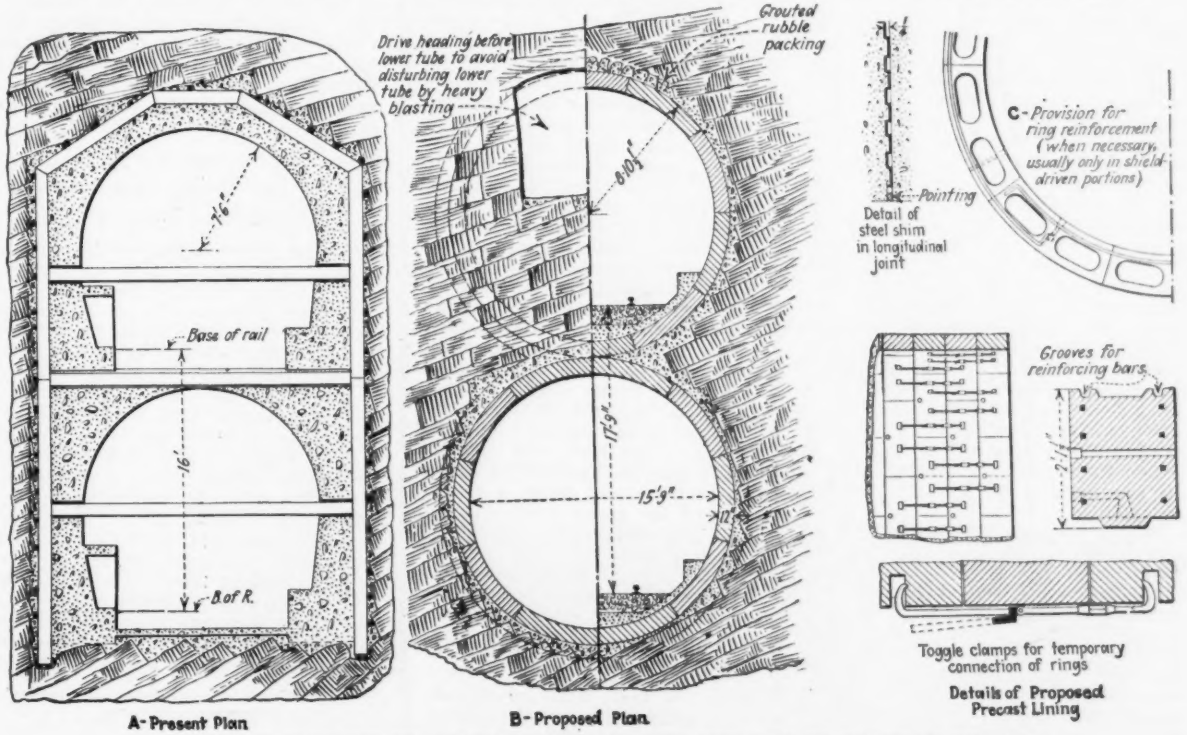
concrete blocks for shield tunneling in place of cast-iron segments (as fully described in *Engineering News-Record* of Aug. 3, 1922, p. 174).

In view of this successful European use of precast lining for rock tunnels and its satisfactory employment in several soft-ground American tunnels, the writer believes that serious consideration should be given to the advantages which it offers under such conditions as those in 53rd St. By building a block lining in rings so constructed as to have immediate arch strength, marked improvement is realized over the old way of setting them like ashlar blocks; timbering and centering are eliminated, and mechanical erection apparatus may be substituted for hand labor. The individual blocks and the structure itself can be reinforced when desired (sketch *C*), and the concrete be made so dense by vibrating the molds with air hammers that a test strength of 4,000 lb. per sq.in. in 30 days is obtained.

The application of such block lining to two separate single-track tunnels, driven progressively, in place of the single mass-concrete structure is indicated in sketch *B*. Various details show interlock between successive rings of blocks, the projections at the back of the leading ring fitting into recesses in the preceding ring, the projections, however, having excess depth which results in leaving a ¼-in. joint space between the two rings for grouting. Longitudinal joints are made up with two ¼-in. shims 2 in. wide, of corrugated steel plate of $\frac{1}{16}$-in. metal, giving the ring immediate strength as an arch and yet permitting the flow of grout through the joints from ring to ring. An electric erector would place the blocks, and longitudinally sliding bars attached to the erector platform would support them until the ring is keyed up. As soon as a block is erected it would be tightly attached to the previous ring by two toggle clamps engaging the erector holes of the second ring back, which arrangement would permit the joints to be pointed at once, ready for grouting.

Dry rubble packing would be placed back of the ring as soon as the blocks are set. Excavation and lining would go on simultaneously, as muck and material cars can pass under the erector platform. The tunnel would be divided into five-ring lengths for grouting, by pointing the end joints and rubble packing every fifth ring. This would confine the flow of grout to a length of five rings, and the grouting of this section would not only fill every joint in the lining, but would seal and cement up the rubble packing and also fill all the nearby seams and cracks in the rock.

Particularly in schistose and seamy rock such as the Manhattan schist, effective grouting is believed to be of utmost importance with respect to both stability and strength of the structure. If properly conducted, it can be made the most important aid which the tunnel builder has, in such ground. Carried on in a manner previously described, the grout will continue to flow from the mixer with increasing resistance after the joints and seams are filled as far as the grout can go, during which the superfluous water will filter out of the grout into the ground beyond until the whole mass has the consistency of stiff putty, permitting the hydraulic pressure to be transmitted through the still plastic body of grout and forcing it to refusal into every space in lining, rubble packing, and rock. Thus, the lining and the surrounding ledge are cemented together into an integral structure, strong and tight.


Drive heading before lower tube to avoid disturbing lower tube by heavy blasting
Grouted rubble packing
16'
Base of rail
16'
B of R.
A- Present Plan
B- Proposed Plan
Pointing
Detail of steel shim in longitudinal joint
C- Provision for ring reinforcement (when necessary, usually only in shield-driven portions)
Grooves for reinforcing bars
Toggle clamps for temporary connection of rings
Details of Proposed Precast Lining

COMPARISON OF TUNNEL CONSTRUCTION METHODS FOR 53RD ST. ROUTE TO QUEENS

The writer's reason for advocating the merits of this form of construction is that a quite opposite effect occurs when the attempt is made to line a rock tunnel with concrete molded in place. The concrete then merely blocks the ends of the seams instead of penetrating them, and furthermore is honeycombed if any mortar runs from the concrete into the seams. It is customary to grout such lining through unconnected holes in the concrete, in which case it is virtually certain that most seams will be missed and that the monolithic interbonding of rock and concrete just described cannot be obtained. The contemplated method of constructing the 53rd St. subway line (sketch *A*) appears to involve this result, quite aside from the hazard it presents in requiring a very large opening to be maintained in rock of highly variable structural character, with its strata usually sloping sharply besides the obstacles that heavy bracing makes to placing watertight reinforced concrete.

This discussion is intended to show the advantages that may be realized from using concrete block and grouted rubble lining in the rock tunnel sections of New York's third subway system, though, of course, it applies with equal force to other rock tunnels, especially where conditions require the finished structure to follow the excavation closely, as underneath an operating railroad.

New York,
July 12, 1926.

JOHN F. O'ROURKE,
Consulting Engineer.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Tests Made on Welded and Riveted Connections

Comparative Strength of Structural Steel Connections Tested at Carnegie Institute

An extensive series of structural members and connections, partly riveted and partly welded, was tested last week at Carnegie Institute of Technology, Pittsburgh, for the Westinghouse Electric & Mfg. Co. The members included simple tension members of two angles fitted with end connection plates, plate girders 14 in. deep by 15 ft. long, and various connections of beams to girders and of girders to columns. The purpose of the tests was to demonstrate the variety of structural connections practicable with welding, and the adequacy of such connections for structural service.

All tests were made in the 400,000-lb. screw testing machine of the Carnegie Institute materials testing laboratory. The results, to be reported more fully next week, showed entirely satisfactory behavior of all specimens tested, both riveted and welded. Generally, the members showed a yield point or elastic limit under load representing fiber stresses of 35,000 to 40,000 lb. per sq.in. and failed at fiber stresses ranging from 47,000 to 59,000 lb. per sq.in.

In the case of the beam specimens and those involving connections of beams to girders or columns, the type of failure was in every case buckling (either lateral or vertical) of the compression flange. In three of the connections of beams to girders by welding, the welded connections failed, though this occurred at loads about equal to those which similar specimens stood without failure. All the other welded connections held, although loading was continued until far beyond maximum load.

In the case of the tension members, made of two angles 2½x2x⅜ in., elastic failure occurred at about the same load, but the welded member, having no rivet-hole deduction, reached a higher maximum load. In the plate girder tests two riveted girders had their yield point at 37,400 lb. per sq.in. in the flange, and maximum loads at 46,800 and 50,600 lb. per sq.in. respectively. A welded girder of precisely the same make-up reached its yield point at 46,500 lb. per sq.in. and its ultimate at 53,600. A welded girder made of a single plate for each flange, welded to the web by corner beads, a cover plate on the compression flange, and vertical plate stiffeners, showed an elastic limit at about the same point as the other girders, but by virtue of its heavier compression flange and greater rigidity reached a maximum load of 110,350 lb., or 56,500 lb. per sq.in. flange stress before failure occurred.

Engineering Fifty Years Ago

From *Engineering News*, Aug., 1876

THE Spring Valley Water Co., which furnishes the water supply for the city of San Francisco, is about utilizing a recent purchase of water rights in the Calaveras Valley, Cal., and in so doing is about to engage in a work of the greatest magnitude. The water-shed which is to be used is situated some ten miles above Sunol, on the Central Pacific Railroad, and is about thirty miles distant from San Francisco in a straight line. Being separated, however, from the city by San Francisco bay, a much longer distance is necessary to be covered in bringing the water from the mountains into the reservoir. At the mouth of the Calaveras Valley is a narrow gorge, and through this the Calaveras creek runs. In this gorge a dam 150 ft. high, 700 ft. long, a quarter of a mile in width at its base and 100 ft. at its apex, will be built in order to back up and make a reservoir of the gorge itself. From the lake thus created, a tunnel, some three miles long, will be built. It is to be of brick and cement, will have an arch 7 ft. in the clear, and will carry about 2,000,000 gal. of water a day. At its outlet will be a large filter and from this a 4-ft. pipe line will run past Milpitas, Alviso, and Menlo Park, for a distance of twenty-two miles, and will discharge into a brick canal 10 ft. wide and 4 ft. deep; this latter will conduct the water thirty miles farther, to the San Andreas and Crystal Springs reservoirs, whence it will be distributed through the city. The total cost of this immense work is placed at about $6,000,000, and it is expected that it will be entirely completed by the fall of 1881.

Arbitration Guide to Be Published

The publication of an official guide to civil and commercial arbitration is to be made by the American Arbitration Association, according to a recent announcement of the association. The handbook will bring together the whole information concerning arbitration and will be a codification of the standard procedure under federal law and the laws of the various states. It is expected that the handbook will be ready for publication in the fall.

Large Foundation Contracts Let

Contracts for the substructure of the two bridges which the Port of New York Authority is building over Arthur Kill have been let. Contract for the New Jersey side of the bridge between Tottenville and Perth Amboy was let to the P. J. Carlin Construction Co. for $1,386,100 and the New Jersey side of the Elizabeth-Howland Hook bridge to the Triest Construction Co. for $946,-750. Contracts for the work on the Staten Island side of both bridges were let to the Frederick Snare Co. for $1,909,960 and $1,350,620. Tenders are now being called for on the superstructure of both bridges.

Levee and Traffic Improvement District Formed

The preliminary plan for the formation of the Dallas Levee and Traffic Improvement District to reclaim for industrial purposes 11,500 acres of bottom overflow land along the Trinity River between Dallas and Oak Cliff, Texas, was approved by the Dallas County Commissioners' Court on July 25 and a board consisting of John J. Simmons and two others was appointed by the court to have charge of the work. The estimated cost is $6,000,000. E. N. Noyes of Dallas is engineer of the district. Plans must be prepared and submitted to B. F. Williams, state reclamation engineer, Austin, for approval. Then commissioners of benefits and damages must be appointed, their work done, hearings held, petitions for an election put through and a favorable vote obtained before construction can be started.

Moffat Tunnel Cave-in Entombs Six of the Men

A cave-in which occurred 12,000 ft. in from the West portal of Moffat tunnel on July 30 resulted in the death of one man and the probable death of five others. The men were working in the enlargement of the railroad tunnel. They were just building a jumbo and had the rock all braced up when one big piece broke loose and fell on the jumbo set and broke the braces which were holding the rock. The destruction of the jumbo brought down about three or four hundred tons of hard slabby rock which caught the men underneath the mass of broken timber. One man who was near the outer edge of the pile, was rescued but was so badly injured that he died after reaching the hospital. According to the latest reports, none of the other five men have been reached by the rescue working crew and as no sounds have been heard from within the mass of rock and debris, it is presumed that they are dead.

Philadelphia to Build Two Bridges Over Schuylkill River

Two new bridges are to be constructed across the Schuylkill River at Philadelphia, one over the lower portion of the river, connecting between Gray's Ferry Avenue and West Philadelphia, and the other over the upper portion of the river, between the city and Montgomery county.

The bridge over the lower portion of the river is designated the University Bridge, and will connect with a new parkway to be constructed along the west bank of the river. Plans for the bridge are now being prepared and construction will be started as soon as possible. The cost of the bridge is estimated at $850,000 and funds in the amount of $1,300,000 have been authorized and are available for the work. The structure will be a double-leaf trunnion bascule bridge of span 100 ft. between fenders with a clearance height of 30 ft., carrying a 54-ft. roadway and two 9-ft. sidewalks. The piers will be founded on rock 45 ft. below water.

An unusual feature in the design of the University Bridge is that none of the construction or operating machinery will extend above the roadway level. The design has been developed to secure a clear deck. The movable spans will be electrically operated, with power supplied from the trolley circuits.

The bridge between the city and Montgomery County, which is to be paid for jointly, will be located at Green Lane in Philadelphia and will replace an existing wrought-iron truss bridge which is in such condition that loads are limited to five tons. The new bridge will have four flat reinforced-concrete arches of about 92 ft. over the river and a girder span over the Manayunk Canal on the east bank. It is to be constructed so as not to interfere with traffic, by building the south half first, then opening it to use and removing the old bridge to permit construction of the north half of the new structure. The new bridge will have a 36-ft. roadway and two 8-ft. sidewalks.

Activated-Sludge Plant for City of Fort Lauderdale

An activated-sludge plant with a capacity of 3 m.g.d. is to be built by the city of Fort Lauderdale, Fla. There will be a pre-sedimentation tank of a mechanical, self-cleaning type, with a detention period of 45 minutes. Each of the four aerating tanks will have a capacity of 0.75 m.g.d. with six hours detention. There will be two final settling tanks with a detention period of one hour. There will also be two single story sludge-digesting tanks. Air diffusion will be effected by means of filtros plates located at one side and supplemented by deflectors placed to aid in giving a circulatory motion to the sewage. There will be a small re-aerating channel more for the purpose of returning sludge to the inlet of the aerating tank than for conditioning the sludge. Solomon-Norcross Co., Atlanta, Ga., are engineers for the sewage-works.

Serious Landslide Occurs at Memphis, Tennessee

A serious landslide occurred on the face of the bluff on the Tennessee side of the Mississippi River at Memphis, on July 25. A section of land at the foot of Butler Street estimated to be 1,000 ft. long and nearly 250 ft. deep broke away and slowly settled down into the river valley until the original surface was about 50 ft. below its former position. The slide carried with it the whole plant of the West Kentucky Coal Co. except an office building which stood at the south end of the property. Adjoining property was slightly damaged and much of it endangered. Considerable trackage of the St. Louis and San Francisco Railway was destroyed. The progress of the slide was slow, the total time between the start and the final coming to rest of the mass was about an hour.

Very little of the earth slipped into the river and it has not been determined whether the slide was due to direct action of the river or to a change of conditions within the bluff itself.

The landslide was not entirely unexpected as cracks which had developed a considerable distance back from the edge of the bluff had been under observation for some time and much of the coal in storage in the yards had been removed.

As there are more cracks in the neighborhood of the slide, the contents of other buildings are being removed in case the affected area is enlarged by a further movement of the whole mass.

Pere Marquette R.R. To Build Experimental Track

A ¼-mile stretch of permanent track construction of concrete and steel, as designed by F. H. Alfred, president of the Pere Marquette R.R., is to be built this summer near Detroit. In this design, described in *Engineering News-Record* of Dec. 10, 1925, p. 958, a reinforced-concrete slab 10 ft. wide and 18 in. thick takes the place of ballast and ties. Steel trusses embedded in the concrete have the rails secured to the top chords by bolted clips, each chord consisting of two plates or bars placed on edge. It is proposed to build the slab continuously, without expansion joints.

Hoosac Tunnel to Be Enlarged

The work of enlarging the Hoosac tunnel to make it possible to operate large freight cars through it has been begun by the Boston and Maine Railroad Co. The tunnel, which is about five miles long, is double tracked but is not high enough to permit the passage of many of the large freight cars now in service. It is proposed to operate the tunnel as a single-track railroad, using the east bound track while the west bound track is being cut down to a lower grade and when that work is completed operate over that track while the east bound track is being cut down. The work is to be carried on continuously, the men working three eight-hour shifts. It is to be completed by fall.

Brubaker Aerial Surveys

WILLAMETTE RIVER BRIDGES, PORTLAND, ORE.

Airplane view of three bridges across the Willamette River at Portland, Ore. The white structure in the foreground is the Burnside bridge, a double-leaf, bascule lift span recently put in service. Foundation work of an interesting nature on this structure was described in *Engineering News-Record*, Oct. 8, 1925, p. 584. The next bridge is a double-deck railroad and vehicular crossing known as "the railroad bridge," and in the background is the Broadway bridge used by vehicular and street-car traffic.

Dredging Contract for Miami

The War Department has awarded to the Arundel Corporation of Baltimore, the contract for dredging the main channel and constructing jetties in Miami (Florida) Harbor. The estimated cost of the work to be done is approximately $2,300,000.

Short Railway to Connect With The Soo Line

The Interstate Commerce Commission has authorized the Minneapolis, Northfield & Southern Railway Company to extend its line from Golden Valley to conect with the Minneapolis, St. Paul & Sault Ste Marie at Crystal, Minn., a distance of approximately 6 miles.

Nation-Wide Survey of Use of Buses Begun in Chicago

On July 27 the Interstate Commerce Commission began a hearing to determine the extent of the use of buses by railroad companies, and the amount of competition of buses with the railroad. The hearing begun at Chicago will be continued at St. Paul, Minn., Portland, Ore., San Francisco and Los Angeles, Calif., Denver, Colo., Detroit, Mich., Boston, New York, Ashville, N. C., Dallas, Tex., Kansas City, Mo., and Washington, the final hearing being held in Washington on Sept. 29 and the following days. Officials of fifty-one railroads in the United States and Canada, which supplement their rail service with motor trucks and buses, will be called upon to testify, and to furnish statistics concerning their own experience.

At the conclusion of the hearing the Commission will report to Congress what legislation, if any, should be enacted to regulate motor transportation.

Defects in Klamath River Bridge to Be Subject of Report

Acceptance of the concrete arch bridge across the Klamath River in California, a Federal Aid project, has been delayed by the finding of "defective work in the arch rings" which "appears to be serious" according to R. M. Morton, chief engineer, California State Highway Commission. An article on the bridge appeared in *Engineering News-Record*, June 17, p. 991.

Mr. Morton announces that the bridge will not be open to traffic until repairs have been made and to be sure of adopting the best methods of repair a board of outside engineers has been retained to report on the condition of the structure and the remedial measures necessary. The board consists of Henry D. Dewell, consulting structural engineer, San Francisco, Merrill Butler, structural engineer, city of Los Angeles, and C. E. Andrews, bridge engineer, Washington State Highway Department. In their examination of the structure these engineers were accompanied by J. V. McNary, senior highway bridge engineer, U. S. Bureau Public Roads.

Washington Roebling, Builder of Brooklyn Bridge

Washington Augustus Roebling, who with his father John A. Roebling built the Brooklyn Bridge, died July 21, at Trenton, N. J., in his 90th year. He had been failing for some months. His death leaves vacant the presidency of the John A. Roebling's Sons Co., an office which he held fifty years ago, when the company was first formed, and which he re-assumed five years ago upon the death of his nephew Karl G. Roebling.

Washington Roebling was born on May 26, 1837, at Saxonburg, Pa. His

Washington A. Roebling

father, one of the pioneer founders of the town, started a wire-rope factory there in 1841, but moved it to Trenton eight years later, establishing it on the site of the present plant. The boy received his early schooling partly in Pittsburgh and partly in Trenton, and then attended Rensselaer Polytechnic Institute at Troy. After his graduation in 1857 he went to work on the construction of the Allegheny River suspension bridge at Pittsburgh, which his father had undertaken, but with the outbreak of the Civil War he enlisted as a private. He was soon made engineer on staff duty, and his war service continued throughout the hottest campaigns, including incidentally some noteworthy items of suspension bridge construction and repair. Late in the Richmond campaign in 1864, he served as Colonel on the staff of General Warren, of the Fifth Corps, and in the following year, resigning from the army, he married Emily Warren, sister of his former commander, and went to Cincinnati on the construction of the Covington suspension bridge.

Brooklyn Bridge

At this time the Brooklyn Bridge project was already alive and Colonel Roebling took an active part in it as soon as he returned from the Cincinnati work. In 1869, before the bridge was even begun, his father died from an injury received during the preliminary surveys, and Washington took over the great enterprise. At the same time he, with his brothers Ferdinand and Charles, took up the management of the wire works at Trenton, organizing the present company; he became its first president, though he soon gave up the office, as the Brooklyn Bridge demanded his full attention.

During the sinking of the New York caisson for the bridge in 1872 he was overcome by excessive exposure to compressed air, and throughout most of the remainder of the construction of the bridge he was confined to the house and compelled to direct the work from the distance of his window on Brooklyn Heights, overlooking the site. Even in 1883, when the bridge was formally opened, Colonel Roebling was not fully restored and traces of the attack remained with him ever after.

Return to Active Life

After completion of the great bridge, Colonel Roebling lived for a time in Troy, but in 1888 returned to Trenton, where he remained until his death. He married Cornelia Farrow in 1908, his first wife having died five years previously. In 1921, when his nephew's death made it necessary for him once more to take up active direction of the company's affairs, at the age of 84, he nevertheless threw himself into the work with youthful energy, and carried out important development of the plant. During his administration, also, the company contracted for and made the cable wire for the Bear Mountain suspension bridge, a longer span than any previously built.

Colonel Roebling's activities outside his company included many business, financial and civic connections in Trenton. His principal scientific interest was in mineralogy, and he brought together a collection of some 15,000 mineral specimens, said to be one of the most complete in the country. Throughout his life he maintained close contact with Rensselaer Polytechnic Institute, where he obtained his professional education; a dormitory and a broadcasting station given to the Institute figure among his many philanthropic donations.

Two Railway Projects to Start Soon in Canada

Contracts have been let by the Aluminum Company of Canada, for an extension to the Roberval-Saguenay Railway in the province of Quebec, recently taken over from the original proprietors. The road at present is 37 miles long, and it is proposed to extend the line from the Saguenay River bridge to the mouth of the Shipshaw River, a distance of three miles.

The Legislature of the province of Alberta, Canada, has authorized the Government to raise $775,000 for the construction of 27 miles of railway to tap the Pembina Valley country. A contract has been let for the grading and it is expected the work will be completed this year.

Boston District Water Supply Commissions Appointed

Appointment of the two non ex-officio members of the commission created to provide an additional water supply for the Boston Metropolitan District and Worcester, Mass. (see our issue of June 10, pp. 929 and 934) was announced by Governor Fuller on July 21. Both are lawyers with experience in business and public affairs: Joseph H. Soliday of Dedham, and Charles M. Davenport, of Boston. The appointments are for five years at a salary of $4,000 a year. As designated by the legislature, the chairman of the special commission is David R. Keniston, who is also chairman of the Metropolitan District Commission, which has charge of the existing metropolitan water system. In virtue of his responsibilities, Mr. Keniston will receive an additional salary of $2,500 a year. The duty of the special commission is to provide an additional water supply for Boston and vicinity, but before going on with major operations it must submit plans for the work to the legislature of 1927.

Detroit Technical Societies Urge Council to Act on Sewage

A resolution protesting against the delay of the city council of Detroit, Mich., in acting on the report of the Mayor's Special Committee on Sewage Disposal, composed of engineers and business men, was adopted by the Associated Technical Societies of Detroit on July 12 and sent to the council the next day. The component societies have a total membership of 2,500, including engineers, architects, chemists and members of allied professions.

By request of the mayor, the report was submitted to the council last December by John W. Reid, commissioner of public works, with the suggestion that in view of the urgency of the subject public hearings be held in order that a prompt decision on the recommendations of the engineers could be made and money provided for starting the project in 1926. The committee endorsed the recommendations for Imhoff tanks made by its consulting engineers, Harrison P. Eddy of Boston, John H. Gregory of Baltimore, and Clarence W. Hubbell of Detroit. Perry A. Fellows, city engineer of Detroit, was a member of the committee. An abstract of the report appeared in *Engineering News-Record* for Jan. 21, 1926, p. 112. The plan included intercepting sewers and a pumping station and treatment works to handle the entire sewage of the city. The proposed sewage-works include bar screens, skimming-detritus tanks, Imhoff tanks, and disinfection apparatus.

Soon after the report was submitted a public hearing was held and after that members of the city council journeyed to various sewage-works. Much publicity has been given to a division in the council between adopting the Imhoff tanks recommended by the advisory committee and its engineers or substituting a certain make of fine screens at an alleged large saving in first cost.

Engineering Societies

Calendar

Annual Meetings

NEW ENGLAND WATER WORKS ASSOCIATION, Boston, Mass.; Annual Meeting, Providence, R. I., Sept. 14-17, 1926.

INTERNATIONAL CITY MANAGERS' ASSOCIATION, Lawrence, Kansas; Annual Convention, Colorado Springs, Colo., Sept. 21-23, 1926.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York, N. Y.; Annual Convention, Philadelphia, Pa., October 4-9, 1926.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington, D. C.; Annual Convention, Pinehurst, N. C., Nov. 8-12, 1926.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Louis, Mo.; Annual Meeting, Washington, D. C., Nov. 8-12, 1926.

THE ASPHALT ASSOCIATION, New York City; Annual Meeting, Washington, D. C., Nov. 8-12, 1926.

The American Water Works Association announces several sectional meetings as follows:

California Section: Oct. 28 to 30 at San Diego; Paul E. Magerstadt, secretary, East Bay Water Co., Oakland.

Central States Section: Sept. 21 and 22 at Cleveland, Ohio; E. E. Bankson, secretary, 1111 Union Bank Building, Pittsburgh, Pa.

Iowa Section: Nov. 3 to 5 at St. Louis, Mo.; Jack J. Hinman, Jr., secretary, State Board of Health, Iowa City.

Personal Notes

A. F. MORRIS, for the past five years general manager for R. W. Hebard & Co., Inc., on their highway contracts in Panama, has accepted the position of director of roads for The Ministry of Public Works of Persia and will leave shortly for that country.

J. A. CLARK, Wausau, Wis., has been appointed county highway engineer for Marathon County, Wisconsin, to succeed J. H. Vogt, resigned.

ARNOLD KRAEFT, Watertown, Wis., has been appointed city engineer for Beaver Dam, Wis.

S. YANANGUCHO, engineer for the government railways in Japan, is visiting Canada during the course of an American tour for the purpose of studying the railway systems of the continent.

GARRETT S. DE GRANGE, who for a number of years has been connected with the U. S. Government Picatinny Arsenal, Dover, N. J., as a member of the Engineering Division, has resigned and is now associated with the Ascher Engineering and Construction Co., 1457 Broadway, New York City, in charge of engineering and inspection.

LEWIS E. ROBERTS has been appointed city engineer of Peru, Ind., to succeed the late A. W. Smith.

GUY A. WATKINS, after sixteen years association with W. D. DICKINSON in the practice of civil engineering under the firm name of Dickinson & Watkins, has withdrawn from the partnership. LEONARD WHITE, chief draftsman and office assistant, will become a member of the firm, which will hereafter be known as Dickinson and White.

A. R. CARVER, division engineer, Baltimore & Ohio R.R. at Newark, Ohio, has been appointed division engineer, main line, Connellsville Division, with headquarters at Connellsville, Pa., vice H. R. GIBSON, who has been promoted to be superintendent of Newark Division, at Newark, Ohio.

JOHN M. JOHNSON has formed the Johnson Construction Co. with offices at 1820 American Trust Bldg., Birmingham, Ala., which will engage in general building construction. Mr. Johnson was formerly superintendent for F. M. Hubbell Son and Co., Des Moines, and for Turner & McPherson, Birmingham, Ala.

ROY W. ELLIOTT, formerly business manager of Fairmount College, Wichita, Kansas, has been appointed bursar of the new Municipal University of Wichita at Wichita, Kansas.

Obituary

JAMES W. DEEN, who was division engineer on the Denver & Rio Grande Ry. at Salida, Colo., for twenty-two years, died July 27 after an operation for appendicitis. Mr. Deen who was 73 years of age, retired from actual service three years ago. He came to Colorado from Pennsylvania in 1881.

C. D. HALE, a member of the engineering staff of the structural bureau of the Portland Cement Association, Chicago, died July 24 from a combined attack of influenza and pneumonia. Mr. Hale was a graduate in civil engineering from Northwestern University. He served in France during the World War as a first lieutenant in the artillery and motor transport corps, and lately held a commission as captain in the 65th Division, cavalry reserve corps.

DR. ERNST REITLER, for many years secretary of the International Association for Testing Materials, died at Vienna on June 17, after a long illness. He will be remembered by all who were connected with the International Association for his energetic and devoted attention to the objects and work of the Association, and in particular for his activities in connection with the last Congress of the Association, held in New York in 1912. Dr. Reitler was for many years in Austrian railway service, as engineer of the Nordbahn.

Construction Equipment and Materials

A SECTION DEVOTED TO WHAT THE MANUFACTURER IS DOING FOR THE ENGINEER AND CONTRACTOR

Date Set for 1926 All-Western Road Show

That part of the Panama-Pacific International Exposition grounds in San Francisco, which was used last year will again be the scene of the second All-Western Road Show, October 7 to 15 inclusive, according to President Tracy W. Harron, of the Western Construction Equipment Distributors, under whose auspices the show will be staged. About one million square feet of space will be available for exhibitors, both under canvas and outdoors.

It is planned to hold the Road Show in conjunction with conventions of contracting, state and county official engineering, rock producing and good roads organizations of the Pacific Coast and Rocky Mountain states. Advance orders for space are said to already exceed the gross space used by exhibitors last year.

General headquarters have been established by the committee for the 1926 Show, at 625 Market St., San Francisco, under the direction of P. H. Curtis, executive secretary.

Concrete Road Yardage

For June the square yardage included in concrete pavement contract awards, according to the Portland Cement Association were: 10,793,452 for roads; 5,999,859 for streets; and 524,572 for alleys; or a total for the month of 17,317,883 sq.yd.

The accompanying table summarizes the statistics for the current year:

SQUARE YARDS OF CONCRETE PAVEMENT AWARDED DURING 1926

Month	Roads	Streets	Alleys	Total All Classes
Jan. ...	2,161,415	1,410,201	57,218	3,628,834
Feb. .	2,726,611	2,010,941	274,836	5,012,388
March	4,662,885	3,050,630	224,879	7,938,394
April.	8,758,195	4,324,729	479,763	13,562,687
May. ..	8,910,678	4,619,195	507,250	14,037,123
June. ..	10,793,452	5,999,859	524,572	17,317,883
Totals	38,013,236	21,415,555	2,068,518	61,497,309

British Optical Convention

The report of the Optical Convention recently held at the Imperial College of Science, South Kensington, London, as regards both the technical sessions and the exhibition of British made optical instruments, contains the following remarks, which may be of interest to surveying instrument manufacturers and others in this country.

The adoption of an internal focusing telescope, which prevents the collimation line from being disturbed by refocussing was one of the improvements introduced by British makers in the last year, according to Major E. O. Henrici, who presented a paper. Other improvements consisted of improved methods of viewing the bubble and setting the instruments, all observations being made from a single position of the head; also, the use of a bubble independent of temperature changes was an innovation which was particularly noted. It was remarked that the greatest stride in fifty years has been possible in the manufacture of magnetic compasses by the use of cobalt steel. This use, in combination with a modern damping device in the form of specially designed filaments, has made it possible to regard the magnetic moment and the damping of compasses as variable factors in the design, so that instruments have been evolved for aircraft and high shipbridges where the motion renders old-fashioned types of compasses quite unsuitable.

For aerial photo surveys optical devices have been made which insure that the airplane is piloted in parallel straight lines to and fro, so that every square yard of the ground below is photographed in its turn and without omissions. British opticians were claimed to be in the fore in dealing with the new optical problems arising from the demands of the aerial photo survey business.

At the exhibition the advance made in the design of rangefinders was shown by an instrument made in 1888, designed for work at 1,000 yd, within an error of 40 yd., and one of the present-day rangefinders which measures 40,000 yd. within an error of 100 yd., equivalent to 3 in. at 1,000 yd.

Business Notes

LINK-BELT CO., Chicago, for the sixteenth time in 20 years held its Drive Chain conference, this year on July 7, 8 and 9. The conference was held at the Dodge Works, Indianapolis, and was presided over by James S. Watson, general manager of the plant and of the drive chain division.

READING IRON CO., Reading, Pa., announces the appointment of Robert I. Fretz as district sales manager in the Reading territory. The territory includes New York state and eastern Pennsylvania excluding New York City and Philadelphia.

CHARLES J. MURRAY has recently resigned from the staff of the Linde Air Products Co., New York, to become associated with the Oklahoma Contracting Co. He is now organizing a new division of that concern to engage exclusively in oxwelded pipe line construction.

THE HEIL CO., Milwaukee, Wis., has opened a factory branch office and service station for the New England territory at 298 N. Harvard St., Boston (Brighton), Mass. Clarence H. Zarse, formerly of the general sales staff, has been placed in charge as branch manager. Another announcement is that Howard Winton, formerly advertising manager, in his new capacity as general branch manager is to be in charge of the promotion and activities of all branches and distributors. Arthur Nicolaus has been made advertising manager.

DUNN PAINTING MACHINE CO., Dettner Building, San Francisco, has appointed Charles W. Harris to organize a sales organization for it. Robert S. Weintraub has been appointed special representative for the company.

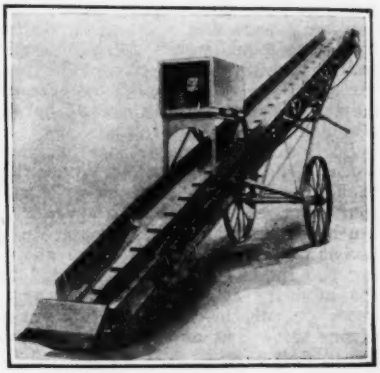
CHAIN BELT CO., Milwaukee, announces that D. B. Catton has been placed in charge of its Portland office to succeed A. C. Sullivan who died recently. Mr. Catton will look after both the chain and conveyor business of the company, while the concrete mixers will be handled by the Loggers & Contractors Machinery Co.

FREDERICK J. W. LUCK, for many years prominent in the engineering counsels of the Westinghouse Electric International Co. in various countries, died in London, England, on July 12. Mr. Luck's death followed an illness which he contracted while in Brazil where he was responsible for the installation of many of the important power plants there. He was transferred from Brazil to the London office of the company in September, 1923, and was retired in July, 1924.

New Developments

Four New Improvements Made on Portable Belt Conveyor

Improvements on the portable belt conveyor made by the Jeffrey Manufacturing Co., Columbus, Ohio, have been designed with the idea of providing a machine more suitable for road construction, building material yards, and industrial plants, where it is desired to handle materials from hopper bottom railroad cars to storage piles or

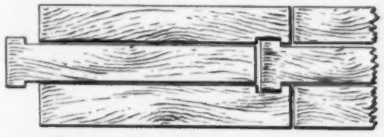


trucks. Improvements recently made are four in number. Steel side boards have been added which are bent under the side of the belt, forming with it a moving trough which provides larger capacity and prevents the material from rolling off. An improved type of carrying idler has been developed to support the loaded portion of the belt. An extended and flared loading leg at the bottom forms a seal with the moving belt and also centers the load on the conveyor. A gate is used at the foot of the conveyor to prevent material from falling into the enclosed boot housing.

The conveyor is built in 18, 24 and 30 foot lengths, powered with either an electric motor or gasoline engine. The elevator may be adjusted to any convenient height and different holes in the pipe struts allow the wheels to be adjusted forward or backward in balancing the load. The belt is 16 inches wide, rubber covered and troughed. The return idlers are designed as a belt cleaning device. Finally steel flights are attached to the center of the belt to increase carrying capacity and are so arranged that they cannot catch on material and tear the belt.

Interlock Wood Sheetpiling

The accompanying drawing shows a section of wood sheetpiling patented by Albert A. Martinez, Title Guarantee Building, New Orleans, La. Ad-



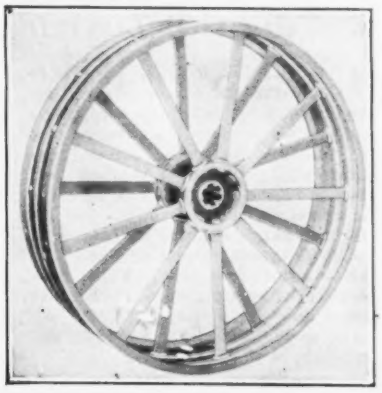
vantages claimed are that the piling is absolutely watertight and that it locks from top to bottom. It has been used on a number of important jobs in the South.

Flat-Spoke Tractor Wheel

A tractor wheel available in various diameters using flat spokes and a flanged and grooved light-weight tire is the latest development of French & Hecht, Davenport, Iowa. Eighteen spokes are used, each having a cross section of 1¼x⅜ inches. The spokes are staggered, the rows being 3 in. apart in the tire and 7 in. in the hub. Spoke ends that pass through the hub flange and the tire are round. The steel spokes are forged while hot into the hub, and have heads formed on the inside of the hub and shoulders on the outside, thus producing a spoke fastening similar to that of a boiler rivet.

The light weight tire has its edges flanged inward and two grooves in the middle. The grooves give stiffness to the tire, and at the same time provide protection for the spoke heads. Also by placing the spoke heads below the base of the tire allows cleats and grousers to be fastened in any desired position. The flanging of the tire is also said to contribute to the light weight.

The wheel is built for a live axle drive and it is claimed that the strength provided to take care of the severe torque loads from the engine results from the fact that the flat sides of the spokes are set parallel to the edges of the tire. In addition the spokes are in a sort



of a trussed position between the hub and the tire and designed to take care of the side thrust loads present when the tractor is working on a side hill and under similar circumstances.

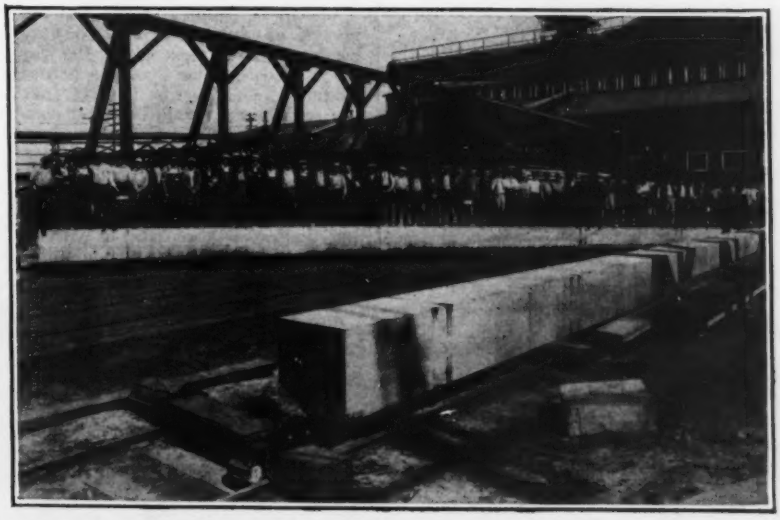
New Publications

Cableway Excavators — SAUERMAN BROS., Chicago, entitles its latest booklet "Excavating for Profit," in which it describes and illustrates how its slackline cableway excavators reduce the cost of excavating work where the digging is deep and the material has to be moved distances of 200 to 1,200 ft. It is, in fact, a treatise on slackline cableway practice, using diagrams and photographs to illustrate a variety of equipment layouts that have been used successfully. Complete information is given on recent improvements in details of equipment, such as excavator buckets, masts, towers and the 2-speed and 3-speed cableway power units.

Air Lift Pumping — SULLIVAN MACHINERY CO., Chicago, in bulletin No. 71-I describes its air lift pumping methods and apparatus. Attention is given to its new air-made well, as well as to its older types of equipment and to the information needed for estimating and deciding upon an air lift pumping plant.

Concrete Waterproofing — TOCH BROTHERS, INC., New York City, has issued a specification and descriptive bulletin covering the use of "R.I.W." Toxement integral waterproofing compound. The bulletin is drawn up in accordance with requirements of the A.I.A. as to filing number and size and gives a number of illustrations of buildings and detailed drawings of the use of the compound.

Diesel Engines—FAIRBANKS, MORSE & CO., Chicago, has available a new 32-page bulletin entitled "Economy in Diesel Engine Power." The booklet takes up an analysis of the various factors which affect the cost of power, such as fuel, labor, maintenance, first costs, fixed charges, reliability and simplicity. The costs for a typical small Diesel power plant are analyzed and compared with similar costs for a steam power plant. A number of chapters are included which give a discussion of the application of Diesels in a wide variety of industries, together with illustrations of Diesel equipped plants.



SPUDS 80 FEET LONG AND 28 INCHES SQUARE CUT AND READY FOR SHIPMENT 7 HOURS AFTER RECEIVING ORDER

The Douglas fir timbers shown ready for shipment were ordered by the American Brown Boveri Electric Corp., Camden, N. J., for use on a dipper dredge building in its yards and were cut from stock in record time by the St. Paul & Tacoma Lumber Co., Tacoma, Washington.

Engineering News-Record Statistics of the Construction Industry

Aug. 5, 1926 — *in the United States* — Vol. 97, No. 6

Engineering News-Record CONSTRUCTION COST Index Number (1913 = 100)

MONTHLY

January, 1925 to Date

August, 1926	208.30
July, 1926	207.80
August, 1925	204.60
Peak, June, 1920	273.80
1913	100.00

1925

Jan.	210.40	May	207.20	Sept.	202.10
Feb.	209.70	June	204.60	Oct.	205.35
March	210.20	July	204.60	Nov.	205.95
April	209.55	August	204.60	Dec.	205.95

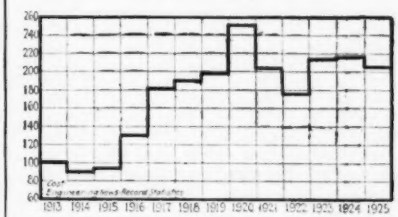
1926

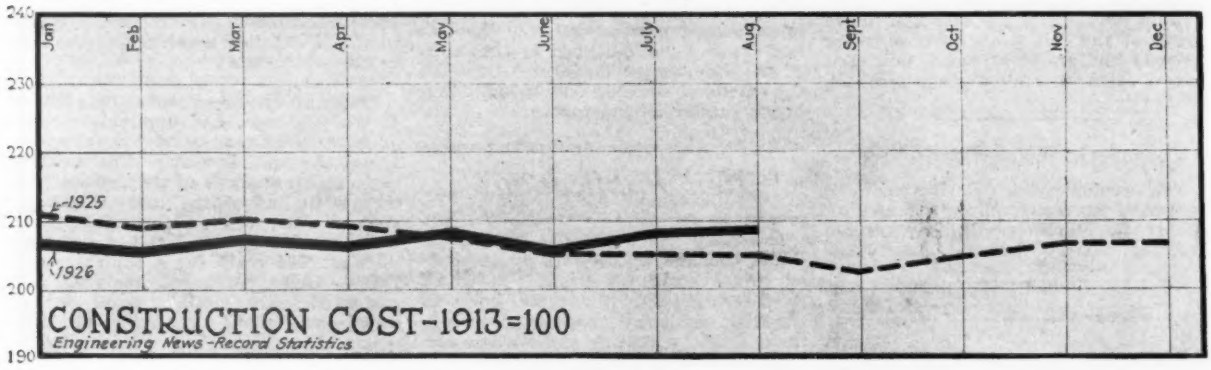
Jan.	207.15	Mar.	207.65	May	207.30
Feb.	206.55	April	207.05	June	204.80

ENGINEERING NEWS-RECORD'S Construction Cost Index Number is 0.2 per cent above July, 1926, owing to increased cost of labor. Materials prices tend downward; decline started six months ago. The average rate for common laborers is 55¼c. per hr. for the entire country as compared with 55¼c. one month ago and 53c. at this time last year. Thus, general construction cost is 1.8 per cent above August, 1925, 24 per cent under the peak and 108 per cent above the 1913 level.

YEARLY

1913 to 1925





Engineering News-Record CONSTRUCTION VOLUME Index Number (1913 = 100)

MONTHLY

January, 1925 to July, 1926

July, 1926	248
June, 1926	246
July, 1925	178
Peak, August, 1925	266
1913	100

1925

January	141	May	209	September	262
February	145	June	214	October	233
March	161	July	178	November	194
April	211	August	266	December	206

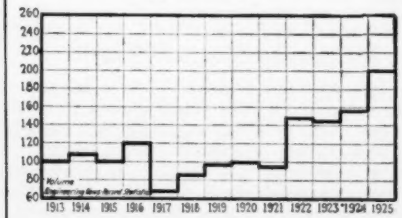
1926

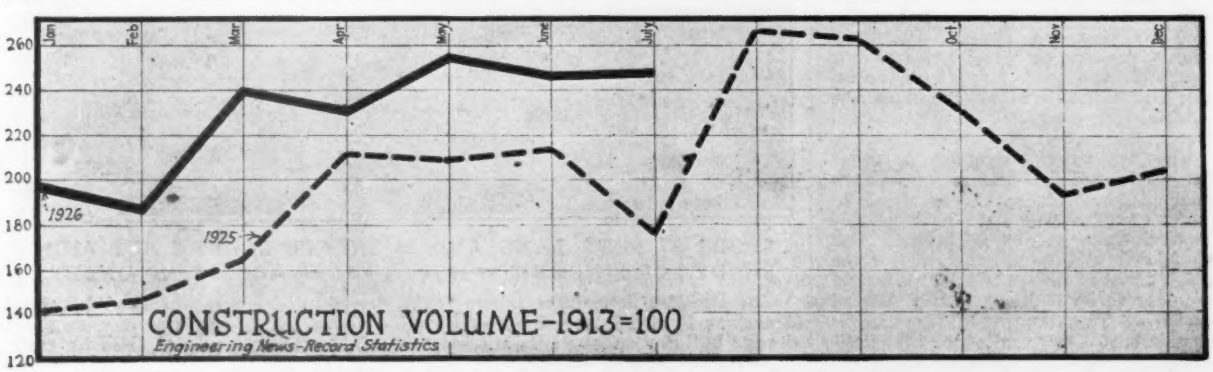
Jan.	198	Feb.	187	Mar.	240
April	233	May	254		

ENGINEERING NEWS-RECORD'S Construction Volume Index Number is 248 for the month of July, and 201 for the whole of 1925, as against 100 for 1913. This means that the actual volume of construction in 1925 (not the mere money-value of the contracts let that year) is 101 per cent above the volume of construction for 1913. The monthly volume number, 248 for July, 1926, contains the increment of construction and indicates the rate at which contracts are being let as compared with 1913 awards.

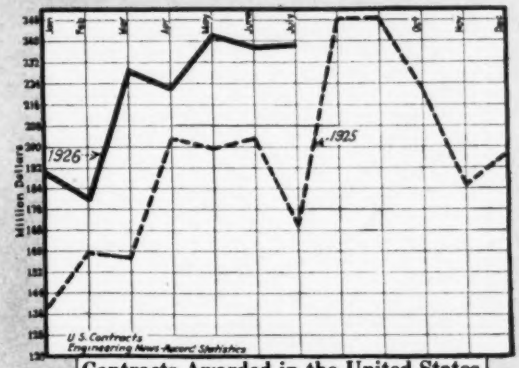
YEARLY

1913 to 1925

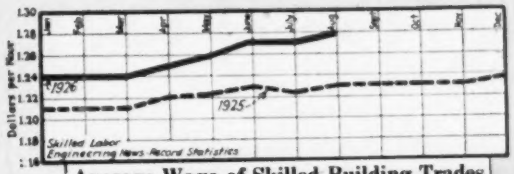




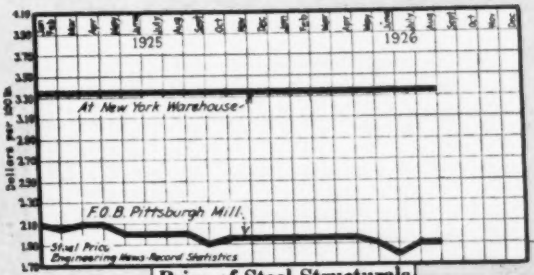
Monthly Statistics of the Construction Industry



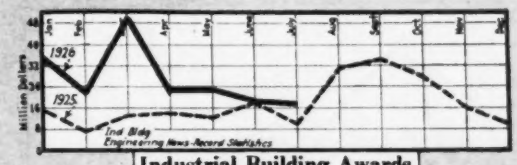
Contracts Awarded in the United States
Reported to E. N.-R.



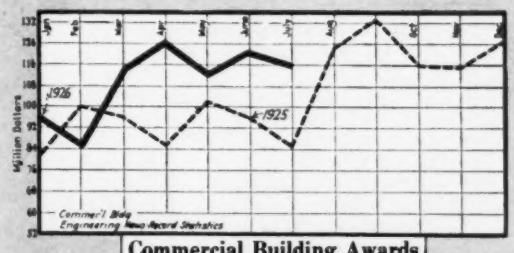
Average Wage of Skilled Building Trades
Bricklayers, Carpenters and Steel Erectors



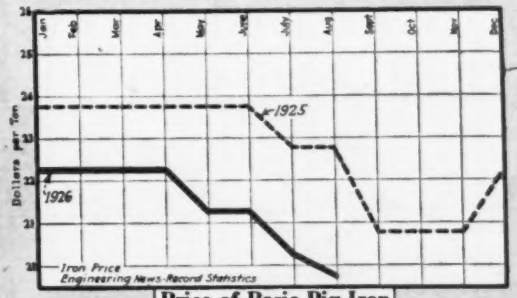
Price of Steel Structurals
Shapes 3-In.; Plates ¼-In.



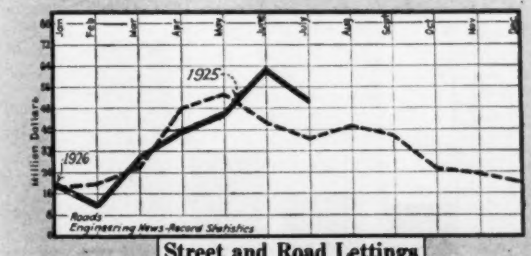
Industrial Building Awards
$40,000 and Over



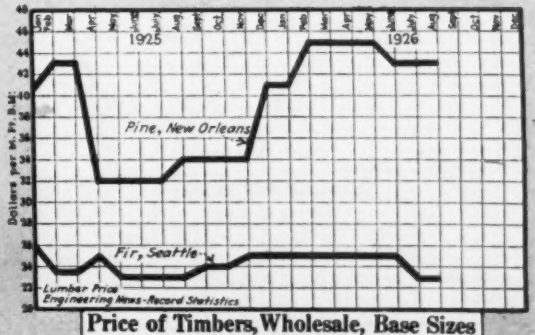
Commercial Building Awards
$150,000 and Over



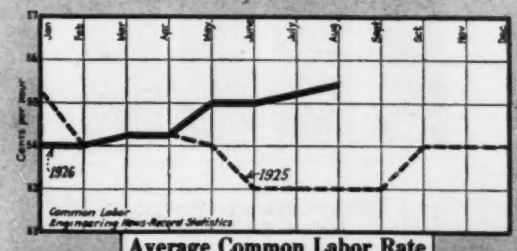
Price of Basic Pig Iron
F.o.b. Pittsburgh



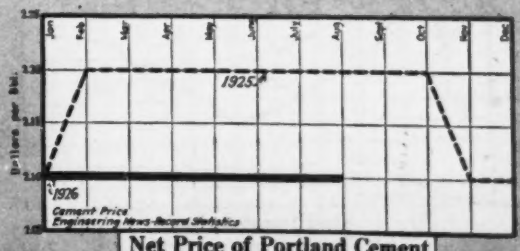
Street and Road Lettings
$25,000 and Over



Price of Timbers, Wholesale, Base Sizes
Car Lots to Contractors

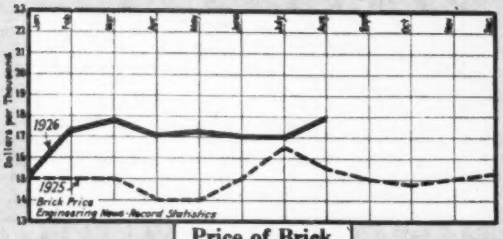


Average Common Labor Rate
Pick and Shovel Men

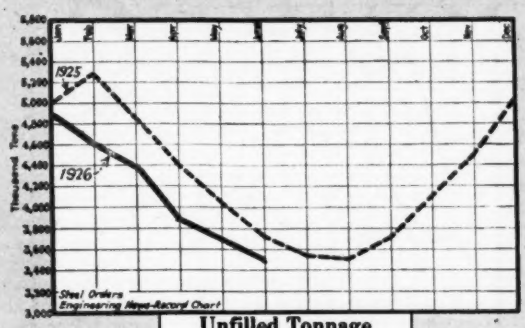


Net Price of Portland Cement
Car Lots, F.o.b. Chicago

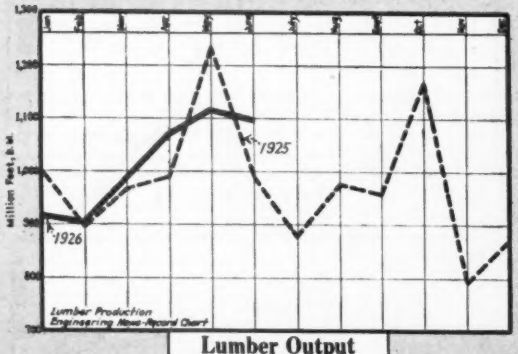
Monthly Statistics of the Construction Industry



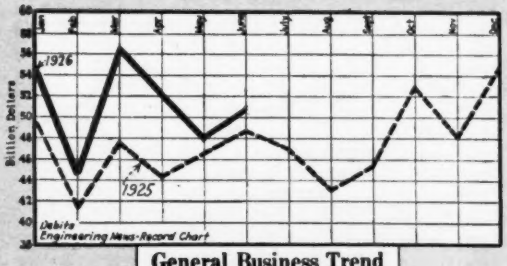
Price of Brick
At Dock, New York



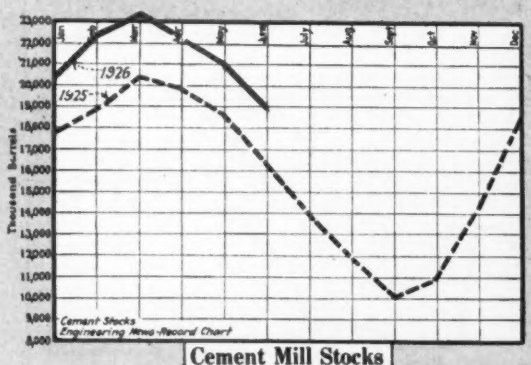
Unfilled Tonnage
On Books of U. S. Steel Corp.



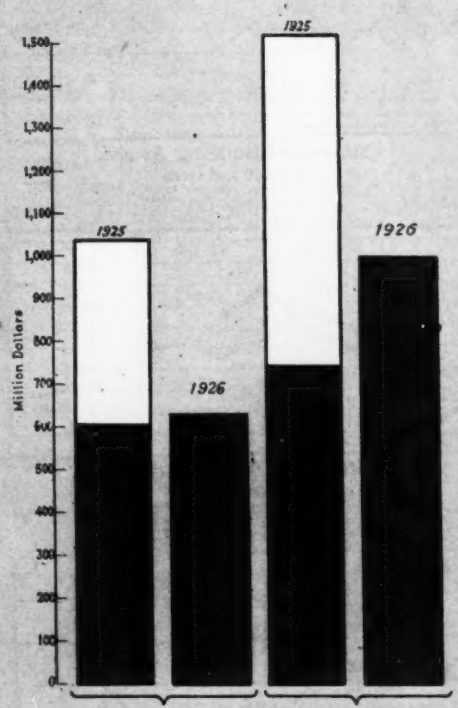
Lumber Output
Nat. Lumber Mfrs. Assn.



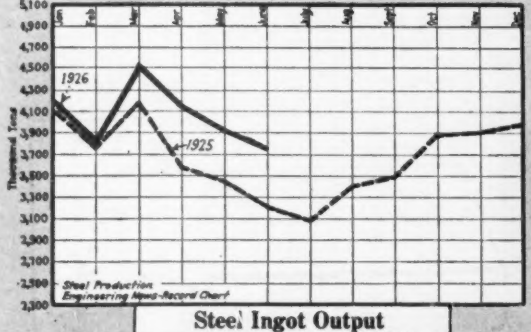
General Business Trend
Bank Debits—Federal Reserve



Cement Mill Stocks
Bureau of Mines



Public—Contracts—Private
Jan. 1 to date ▬
Reported by E. N.-R.



Steel Ingot Output
Gross Tons; Am. Iron and Steel Inst.

July Volume of Contract Letting Heaviest For That Month On Record

Both Projected Work and Awards Substantially Ahead of 1925

TOTAL money value of engineering construction contracts for the entire U. S. in July was $299,099,000 as against $212,509,000 for the same month last year, according to *Engineering News-Record* statistics.

Buildings, and construction other than buildings, both gained 41 per cent in total contracts, comparing July this year with last. These figures include all water-works and excavating jobs valued at $15,000 and over; other public works, $25,000 and up; industrial building at a minimum of $40,000; and commercial, educational, religious and other buildings of $150,000 value or more.

Contracts awarded for the entire U. S., Jan. 1 to Aug. 1, 1926, were 23 per cent ahead of the same period last year. The totals were $1,659,106,000 and $1,350,868,000, respectively. At the same time, proposed work amounted to $3,363,759,000 as against $2,856,487,000 for the first seven months of 1925, a gain of 17 per cent in buildings and 19 per cent in construction other than buildings.

The gain in building projects is significant in that many of the principal cities report a steady decrease since 1924 in shortage of business buildings, apartments and single family dwellings.

Absence of actual shortage does not necessarily inhibit building operations, since present demand for new and better accommodations and full ability on the part of the public to pay for them, plus steady growth in population, serve to insure a large volume of future construction. This ability to pay for construction is based on prevailing high wages, full employment of labor, easy money rates and absence of further inflation in materials' prices.

The actual volume of July contract letting, that is, when corrected for the inflations in costs that have occurred since 1913, is greater than that for any month this year except May and is the heaviest July on record.

July Contracts For U. S. At Minimum Mentioned

1913	$61,730,000	1920	$121,893,000
1914	72,880,000	1921	103,251,000
1915	68,596,000	1922	116,670,000
1916	81,359,000	1923	155,023,000
1917	80,207,000	1924	199,279,000
1918	96,386,000	1925	212,509,000
1919	139,455,000	1926	299,099,000

Volume of July Contract Letting

1913	100	1920	83
1914	139	1921	115
1915	129	1922	146
1916	136	1923	151
1917	87	1924	161
1918	107	1925	178
1919	122	1926	248

All states showed gains in contract letting, comparing July with the same month last year, except the following thirteen: New York, New Jersey, Pennsylvania, South Carolina, Minnesota, Oklahoma, Wyoming, Utah, New Mexico, Arizona, Washington, Oregon and California.

Value of Contracts Let in the United States and Canada During July, 1926

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States	Jan. 1 to Date U. S.	Canada
Water-works	$796,000	$874,000	$406,000	$1,416,000	$1,763,000	$37,000	$5,292,000	$34,626,000	$25,000
Sewers	204,000	1,000,000	296,000	6,133,000	1,695,000	680,000	10,008,000	57,993,000	27,000
Bridges	362,000	2,046,000	2,229,000	1,709,000	1,127,000	406,000	7,879,000	42,562,000	108,000
Excavation, drainage, irrigation	129,000	170,000	486,000	33,000	896,000	173,000	1,887,000	14,254,000	.....
Streets and roads	3,143,000	14,075,000	12,183,000	17,241,000	11,801,000	4,882,000	63,325,000	285,798,000	2,727,000
Industrial buildings	1,979,000	3,004,000	2,065,000	11,829,000	1,495,000	1,261,000	21,633,000	196,254,000	2,800,000
Commercial buildings	26,937,000	35,198,000	5,115,000	50,667,000	14,814,000	12,038,000	144,769,000	847,074,000	5,983,000
Federal Government	132,000	948,000	2,654,000	1 274,000	1,314,000	1,190,000	7,512 000	29,930,000	.....
Unclassified	312,000	6,183,000	530,000	3,983,000	24,708,000	1,093,000	36,794,000	150,615,000	4,807,000
July 1926	$33,994,000	$63,483,000	$25,964,000	$94,285,000	$59,613,000	$21,760,000	$299,099,000	$1,659,106,000	$16,477,000
June 1926	24,260,000	77,073,000	14,402,000	66,626,000	32,078,000	23,186 000	237,625,000	.....	10,434,000
July 1925	14,486,000	78,340,000	12,389,000	39,424,000	35,506,000	32,404,000	212,509,000	.....	7,570,000
Jan. 1 to date, 1926	137,193,000	516,319,000	182,504,000	404,762,000	250,709,000	167,619,000	1,659,106,000	.....	79,398,000
Jan. 1 to date, 1925	114,602,000	466,035,000	109,347,000	240,091,000	241,321,000	179,472,000	1,350,868,000	.....	48,101,000

Labor Rates and Conditions Throughout the Country

Building Trades Schedules Higher

WAGES of labor represent at least 53 per cent of present construction cost, according to *Engineering News-Record* statistics. Scattered adjustments upward, continue to develop in both the skilled and unskilled grades.

Skilled building trades mechanics receive an average rate, for the entire country, about 0.7 per cent above a month ago and 3 per cent more than in August, 1925.

The common laborers' rate is 0.4 per cent higher than in July and 5 per cent above a year ago.

This month shows a slight increase in the number of building trades strikes, compared with last.

The nine most important active controversies are as follows:

San Francisco—Carpenters walkout, started nearly three months ago, in opposition to open-shop conditions, has resulted, thus far, in 159 arrests for violence.

Los Angeles—Situation among carpenters somewhat similar to that in San Francisco.

Boston—Outlaw strike reported among cement finishers.

Fresno, Calif. — Bricklayers are on strike for increase of $1 per day.

St. Louis—Electrical workers on strike in an apparent effort to enforce the closed-shop principle in telephone apparatus installation.

Syracuse, N. Y.—Carpenters strike started Nov. 1, 1925, still unsettled. The men demand an advance to $1.25 per hr. from the present scale of $1.12½.

Holyoke, Mass.—Plumbers striking for $1.12½ per hr., an advance of 12½c. over the prevailing rate.

New Haven, Conn.—Hod carriers and plasterers' helpers on strike, demanding 10c. per hr. advance over existing wages of 65c. and 75c. per hr., respectively.

Cleveland—Painters refuse a profferred advance of 5c. per hr. as against 12½c., demanded by the craft when it went on strike in March.

Among the principal settlements reached during the last month, were the following:

Boston—Cement finishers returned to work at $1.25 per hr., after having been on strike since Apr. 1, 1926.

Gary, Ind.—Building trades mechanics returned to jobs following a lock-out which occurred because of the refusal of the craftsmen to handle materials made by non-union labor. Adjustment reached through the U. S. Department of Labor.

Philadelphia—Recent strikes of cement finishers and painters ended in loss for the two crafts involved.

Dallas—Plasterers returned at old rate of $1.62½ per hr.; demand for increase of 12½c. abandoned.

San Mateo, Calif.—Carpenters won the five-day week which went into effect in July.

Chicago—Steam fitters will receive $1.56¼ per hr. on and after Jan. 1, 1927 as against the current schedule of $1.50 per hr. None of the crafts have thus far obtained the contested right of sympathetic strike.

Kansas City, Mo.—Many of the carpenters who went on strike May 8, have reached agreements with employers and returned to the jobs. The original demand was for $1.25 per hr., against the present rate of $1.12½.

Batavia, N. Y.—Plumbers have abandoned strike and returned at old rate of $1 per hr.

Current Building Trades Wage Rates Per Hour

(Higher rates indicated by +, decreases by —)

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$1.12½	$0.70	$0.70	$0.50	.....	$0.75	$0.25@.30
Baltimore	1.62½@1.75	+1.00@1.10	1.00@1.12½	1.00	$0.65	1.12½	.40
Birmingham	1.00@1.50	.35@.87½	.75@1.00	.50@.75	.....	.75@1.75	.20@.40
Boston	1.40	1.25	1.25	.79	1.15	1.25	.50@.74
Cincinnati	1.50	1.31¼	1.31¼	.95	1.31¼	1.31¼	.45@.58
Chicago	1.62½	1.37½	1.37½	.87½	1.37½	1.37½	.82½@.87½
Cleveland	1.50	1.25	1.30	.87½@1.10	1.10	1.50	.87½
Dallas	1.62½	1.12½	1.00	.40@.75	.87½	1.00	.30@.50
Denver	1.62½	1.25	1.12½@1.18¾	.81¼@.87½	1.00	1.15¾	.40@.55
Detroit	1.50	.90@1.15	.85@1.00	.90	.85@1.00	1.12½	.50@.60
Kansas City, Mo	1.50	1.12½	1.25@1.37½	.90	1.12½	1.12½	.40@.75
Los Angeles	1.37½	1.00	1.00	.87½	.80	1.00	.50
Minneapolis	1.25	.87½@95	.87½	.75	....	.87½	.45@.60
Montreal	1.00	.75	.60	.40	.50	.75	.30@.35
New Orleans	1.25	.90	1.00	.75	.85	1.25	.35@.40
New York	1.75	1.50	1.75	1.12½	1.00@1.12½	1.75	.90⅜
Philadelphia	1.50@1.62½	1.12½@1.25	1.02¼	1.12½	1.00	1.12½@1.25	.45@.50
Pittsburgh	1.62½	1.50	1.50	1.12½	....	1.50	.80
St. Louis	1.75	1.50	1.50@1.65	1.15@1.25	1.25	1.50	.45@.75
San Francisco	1.25	1.00	1.00	.81¼	1.00	1.12½	.50@.55
Seattle	1.37½	1.12½	1.00@1.12½	1.00	1.00@1.12½	1.12½	.50@.62½

Monthly Prices of Construction Materials

Ups and Downs of the Market

Pig Iron—With the exception of No. 2 So. at Cincinnati and Bessemer iron at Pittsburgh, prices are substantially below the July level. No. 2 fdry., Birmingham, holds steadily at $21 as against $19 per gross ton in August, 1925.

Railway Supplies—Demand is active in rails and other railway material. Prices of the former hold with customary stability while ties, spikes and bolts are higher.

Pipe—Wrought-steel pipe is in fairly good demand with discounts four points lower at Chicago warehouses. Cast-iron pipe dropped $1 per ton at Birmingham and $2 at Pittsburgh during the month. The declining tendencies in sewerpipe, apparent at this time last month, have subsided.

Road and Paving Materials—Twenty-one cities reporting to *Engineering News-Record* on prices of materials in this class, show the following changes during the month: declines in bulk asphalt of $1 per ton at Chicago and $2 at Kansas City, Mo.; drop of 10c. per lin.ft. in curbing at St. Louis; advance of 9c. per sq.yd. in wood blocks at Minneapolis.

Sand, Gravel and Crushed Stone—Cincinnati market dropped 10c. per ton on gravel, 25c. on crushed stone and 30c. on sand; Baltimore declined 5c. per cu.yd. on crushed stone; Birmingham, 5c per cu.yd. on sand, during the month. Prices of these materials in other cities remain at July levels.

Lime and Cement—There were seven declines to three advances in lime prices during the month. Cement prices are firm with no indications of change.

Brick and Hollow Tile—Quotations on common brick, maximum and minimum considered, moved upward about $2 per M in Philadelphia, Birmingham and New York and declined approximately the same amount in Denver and Cleveland since July 1. A drop of $1.50 per M. also occurred in both Kansas City and Cincinnati markets. The general level is above that of a year ago despite the large volume of brick importations. All price changes on hollow tile reported during the month were declines, principal among which were those occurring in Philadelphia, Cincinnati, Kansas City, Mo., Baltimore and Dallas.

Structural Steel—Steel prices remain fairly steady at levels prevailing a week ago. Bars, shapes and plates hold to a minimum of $1.90 per 100 lb., Pittsburgh mill, with the first two bringing $2 in single carload lots or smaller. The same range of quotations was in effect at this time last month on bars and shapes; plates were 5c. per 100 lb. lower.

Lumber—Prices have been tending downward for a month or more, the decline affecting mainly, 1-in. pine boards, finish, flooring and siding, lath, two-by-fours and red cedar shingles. Firmer tendencies, particularly in the heavy timbers, is noted in certain of the Western and Southern points.

Linseed Oil—The price at New York is 5c. and that at Chicago 1c. per gal. (7½ lb.) above the July 1 level. Apparently the upward trend has been checked with the break which occurred a week ago at Minneapolis.

Scrap—New York and Chicago markets are higher than a month ago. Birmingham reports declines but with better demand for cast products.

Miscellaneous—Structural rivets declined 30c. per 100 lb. at New York warehouses during the month. Wire nails are down 20c. and cut, 10c. per keg, at Birmingham. Galvanized steel sheets were reduced 5c., blue-annealed, 10c., and black, 15c. per 100 lb. at Pittsburgh mills, since July 1. Compared with a month ago, manila rope is 1c. per lb. lower at New York and off 2c. in Denver, Chicago and Minneapolis. Water and sewage treatment chemicals remain unchanged with the exception of copper sulphate, which rose 10c. per 100 lb.

BUILDING materials prices, on the whole, have been declining gradually since February of this year. Steel, with the exception of rivets and nails, is firm. Cement prices remain stable. Comparing this month with last, there is noticeable softening in the market for pig iron, c.-i. pipe, certain of the paving materials, aggregates, lime, brick, lumber, linseed oil, manila rope, and steel sheets.

Shipbuilding Shows Increase In Both Steel and Wooden Vessels

American shipyards were building, or were under contract to build for private ship owners, July 1, 1926, 181 steel vessels of 183,770 gross tons as compared with 159 steel vessels of 209,940 gross tons on June 1, 1926, according to the Bureau of Navigation, U. S. Department of Commerce.

At the same time, a total of thirty-nine wooden vessels of 15,285 gross tons were under contract, or in process of construction for private ship owners, compared with thirty-four wooden vessels of 12,989 gross tons on June 1, 1926.

E. N.-R. Prices of Construction Materials

Price advances since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Per Gross Ton f.o.b.:

	Aug. 5	One Year Ago
CINCINNATI		
No. 2 Southern (silicon 2.25@2.75)	**$24.69**	$23.05
Northern Basic	*20.39*	22.27
Southern Ohio No. 2 (silicon 1.75@2.25)	*21.39*	22.77
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25@2.75)	**27.37**	27.37
BIRMINGHAM		
No. 2 Foundry (silicon 2.25@2.75)	**21.00**	19.00
PHILADELPHIA		
Eastern Pa., No. 2X (2.25@2.75 sil.)	*22.76*	23.26
Virginia No. 2 (silicon 2.25@2.75)	**28.67**	29.17
Basic	*21.26*	22.26
CHICAGO		
No. 2 Foundry Local (silicon 1.75@2.25)	*21.00*	22.00
No. 2 Foundry Southern (silicon 2.25@2.75)	**25.18**	25.55
PITTSBURGH, including freight charge ($1.76) from the Valley		
No. 2 Foundry Valley (silicon 1.75@2.25)	*19.51*	22.77
Basic	*19.76*	22.77
Bessemer	**20.76**	22.77

SCRAP—The prices following are f.o.b. per net ton paid by dealers:

	New York*	Chicago	Birmingham
No. 1 railroad wrought	$13.75@$14.25	**$13.50@$14.00**	$12.00@$13.00
Stove plate	11.00	**14.25@14.75**	14.00@ 4.50
No. 1 machinery cast	.....	16.25@16.75	*16.50@17.00*
Machine shop turnings	9.75@ 10.25	**7.25@ 7.75**	*7.50@ 8.00*
Cast borings	9.75@ 10.00	**10.25@10.75**	*7.50@ 8.00*
Railroad malleable	16.00@16.50	**15.75@16.25**	*15.50@16.00*
Re-rolling rails	12.75	**15.00@15.50**	15.00@16.00
Re-laying rails	.....	.....	21.00@22.00
Heavy melting steel	11.75@ 12.25	**12.50@13.00**	*12.00@13.00*

*Gross ton.

Railway Supplies

STEEL RAILS—The following quotations are per ton f.o.b. for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh				
	Aug. 5	One Year Ago	Birmingham	Chicago	St. Louis
Standard bessemer rails	$43.00	$43.00	$43.00	$43.00	.....
Standard openhearth rails	43.00	43.00	43.00	43.00	$51.00
Light rails, 8 to 10 lb.	.....	30@36	34@36	1.80@1.90*	2.05*
Light rails, 12 to 14 lb.	.....	34@36	34@36	1.80@1.90*	1.88*
Light rails, 25 to 45 lb.	34@35	34.00	34@36	1.80@1.90*	1.84*
Re-rolled rails	28@30	27@28	30.00	34@36	*17@18*

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Chicago, white oak, plain	**$1.45**	**$1.83**
Chicago, empty cell creosoted	**1.90**	**2.45**
Chicago, zinc treated	**1.70**	**2.20**
San Francisco, green Douglas fir	.84	1.14
San Francisco, empty cell creosoted, Douglas fir	1.70	2.25
St. Louis, white oak, plain	1.20	1.50
St. Louis, zinc treated	1.60	1.90
St. Louis, red oak, plain	1.10	1.40
St. Louis, sap pine-cypress	.95	1.25
Birmingham, white oak	1.25	1.45

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh mill for carload lots, together with the warehouse prices at the places named:

	Pittsburgh					
	Aug. 5	One Year Ago	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ⅝-in. and larger	**$2.90**	$2.80	$3.55	$3.65	$4.35	*$2.90@*$3.00
Track bolts	3.90@4.15	3.90@4.15	4.55	4.40	5.85	3.90@ 4.15
Standard section angle bars	2.75	2.75	3.40	3.25@3.75	*3.60*	2.75

Pipe

WROUGHT PIPE—The following discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Iron Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1¼	30	12

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1¼	30	14
2 to 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

STEEL PIPE—From warehouses at the places named the following discounts hold for welded steel pipe:

	Black			
	New York	Chicago	Birmingham	St. Louis
1 to 3 in. butt welded	53%	**54%**	62%	49%
2½ to 6 in. lap welded	48%	**51%**	59%	46%

	Galvanized			
	New York	Chicago	Birmingham	St. Louis
1 to 3 in. butt welded	39%	**41%**	50½%	36%
2½ to 6 in. lap welded	35%	**38%**	47½%	33%

Malleable fittings, Classes B and C, banded, from New York stock sell at list plus 4% less 5%. Cast iron, standard sizes, 36—5% off.

CAST-IRON PIPE—The following are prices per net ton for carload lots:

	Birmingham	Burlington, N. J.	New York Aug. 5	New York One Year Ago
4 in.	*$44.00*	$53.00@55.00	$55.60@57.60	$54.60@55.60
6 in. and over	*40.00*	49.00@51.00	51.60@53.60	50.60@51.60

	Pittsburgh	Chicago	St. Louis	San Francisco
4 in.	*$51.20@53.20*	$53.20@54.20	$51.50	$54.00
6 in. and over	*47.20@49.20*	49.20@50.20	47.50	50.00

Gas pipe and Class "A," $4 per ton extra.

CLAY DRAIN TILE—The following prices are per 1,000 lin.ft.:

	New York					
Size, In.	Aug. 5	One Year Ago	St. Louis	Birmingham	San Francisco	Dallas
3	$45.00	$48.00	$40.00	$45.00	.....	$73.00
4	55.00	50.00	40.00	56.00	$76.50	110.00
5	.....	.....	.....	80.00	97.75	118.00
6	90.00	92.00	70.00	100.00	127.50	150.00
8	160.00	160.00	170.00	165.00	212.50	210.00

SEWER PIPE—The following prices are in cents per foot for standard pipe in car load lots, f.o.b., except as otherwise stated:

Size, In.	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3	.....	$0.088	$0.10	.....	$0.09	$0.12	.....
4	.....	.088	.10	$0.10	.09	.15	$0.15
5	.....	.121	.135	.....	.13½	.18	.18
6	$0.24	.121	.21	.14	.13½	.21	.21
8	.43	.198	.315	.225	.21	.30	.325
10	.52	.231	.45	.315	.31½	.42	.476
12	.66	.297	.54	.405†	.40½	.56	.612
15	1.14†	.396	.75	.675†	.54	.92	1.02
18	1.65†	.55	.90	.945†	.75	1.32	1.53
20	1.98†	.66	1.20	.....	.90	.....	.....
21	.....	.77	.....	1.26†	.....	.....	.....
22	2.65†	.88	1.35	.....	1.20	.....	1.564
24	2.97†	.99	2.665	1.62†	1.35	2.16	2.04
27	4.65†	2.405	2.952	2.45†	2.75	3.00	3.34
30	5.16†	2.664	3.96	3.00†	3.75	3.60	4.06
33	6.98†	3.60	4.51	3.55†	4.50	.....	4.99
36	8.00†	4.10	5.06	3.95†	5.00	.....	5.42

	3	5	8	12	24	36
Boston	$0.125	$0.19	$0.28	$0.58	$2.00†	$5.50†
Minneapolis	.....	.....	.25	.45	1.50	4.56
Denver	.135*	.18*	.27	.47	1.70	.....
Seattle	.14	.....	.35	.72†	2.60†	.....
Los Angeles	.1625	.195	.275	.495	1.65	.....
New Orleans	.116*	.277*	.295	.463	1.785	.....
Cincinnati	.105	.1575	.245	.4725	1.575	4.715
Atlanta	.10*	.15*	.25	.425	1.625	.....
Montreal	.68‡	.45†	.70	1.35	4.50†	.....
Detroit	.105	.1575	.245	.4725	2.16†	5.6375†
Baltimore	.111	.166	.259	.499	1.665	4.92
Kansas City, Mo.	.15*	.21*	.29	.52	1.90†	5.80†
Philadelphia	.11	.16	.26	.42	1.50	3.70

*4-in., 6-in., 9-in., respectively. †Double Strength. ‡3-in. special.

Road and Paving Materials

ROAD OILS—Following are prices per gallon in tank cars, 8,000 gal. minimum f.o.b. place named:

		Aug. 5	One Year Ago
New York, 45% asphalt	(at terminal)	$0.065 @$0.07	$0.065 @$0.07
New York, 65% asphalt	(at terminal)	.0675@ .0725	.0675@.0725
New York, binder	(at terminal)	.07 @ .075	.07 @.075
New York, flux	(at terminal)	.07 @ .075	.07 @.075
New York, liquid asphalt	(at terminal)	.07 @ .075	.07 @.075
St. Louis, 40@50% asphalt		.055	.049
St. Louis, 50@60% asphalt		.0565	.0527
Birmingham, 55% asphalt		.0475	.0475
Dallas, 45% asphalt		.0495	.0495
Dallas, 55% asphalt		.0455	.0455
Dallas, binder		.061	.061
San Francisco, binder, per ton		12.00*	13.50*

* F.o.b. Oleum, Cal. Freight to San Francisco, 80c per ton.

E. N.-R. Prices of Construction Materials

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (*Texas*)	$23.00	$18.50
Boston (*Mexican*)	23.00	18.50
Chicago (*Texas*)	27.00	*22.00*
San Francisco, *f.o.b. refinery*, Oleum, Cal.	18.00	12.00
Dallas (*Texas*)	27.10	21.10
Seattle, *"D" grade, California, f.o.b. Richmond*	19.50	13.50
Denver (*California*)	24.00	.....
Minneapolis, *f.o.b. Twin Cities (Standolind)*	27.60	21.60
St. Louis (*Mexican*)	27.00	24.00
Baltimore (*Standard Oil*) (*f.o.b. refinery*)	22.50	18.50
Montreal (*Imperial*)	28.00	20.68
Atlanta (*Mexican*)	23.40	19.40
Detroit (*Mexican*)	22.25	18.50
Cincinnati (*Kentucky Rock*)	.....	11.65
Maurer, N. J. (*Bermudez*)	30.00	.....
Maurer, N. J. (*Trinidad*)	23.00	.....
Philadelphia (*Mexican*)	20.00	18.00
Kansas City, Mo. (*Texas*)	27.30	*22.30*
Los Angeles (*"D" grade, California*)	*18.00	*12.00
Birmingham (*Mexican*)	27.00	21.00
New Orleans (*Mexican*)	20.00	17.00

* F.o.b. El Segundo Refinery. Drums used in New York.

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums; 200 to 300 gal. to the ton.

PAVING STONE—

New York (grade I)	5-in. granite, 30 blocks per sq.yd	$147.00 per M.
San Francisco	Basalt block 4x7x8	70.00 per M.
Chicago	about 5x8x5 dressed	3.60 per sq.yd
	about 5x8x5 common	3.25 per sq.yd.
Boston	5-in. Granite	135.00 per M.
Atlanta	Granite	2.50 per sq.yd.
Detroit	5-in. Granite	3.00 per sq.yd.
Baltimore	Granite	2.85 per sq.yd.
Montreal	Granite	104.75 per M.
New Orleans	Granite, 4x8x4	2.75 per sq.yd.
Cincinnati	Granite	135.00 per M.
St. Louis	Granite, 4x8x4	1.65 per sq.yd.
Kansas City	Granite	3.15 per sq.yd.
Philadelphia	Granite	3.90@4.25 per sq.yd.
Minneapolis	Sandstone	2.74 per sq.yd.

FLAGGING—

New York	Bronx, 4 ft. wide	$0.24 per sq.ft.
	Manhattan, 4 ft. wide	.24 per sq.ft.
	Queens, 5 ft. wide	.26 per sq.ft.
	6x24-in. cross-walk	1.30 per lin.ft.

CURBING—*New York*: Bluestone per lin.ft., f.o.b. barge New York, 5x16 in., 88c.; *St. Louis*: Class "A" straight, delivered, 5x18 in., 90c. per lin.ft.; roundings, $1.40. *Birmingham*: Limestone, 5x18-in., $1.05 per lin.ft.

WOOD BLOCK PAVING—

	Size of Block	Treatment	Per Sq.Yd.
New York	3	16	$2.40
New York	3½	16	2.70
Boston	3½	18	*2.45*
Chicago	4	16	2.25
Chicago	3½	16	2.10
St. Louis	3½	16	2.45
St. Louis	4	16	2.75
Seattle	4	16	Off market
Minneapolis	3½	16	2.43
Atlanta	3½	16	2.00
New Orleans	3	16	2.20
New Orleans	3½	16	2.30
New Orleans	4	16	2.40
Dallas	4	18	3.90
Baltimore	3½	16	None used
Montreal	4	16	4.50
Detroit	3	16	1.94
Detroit	4	16	.....
Cincinnati	3½	16	2.35
Kansas City	4	16	2.50
Philadelphia	4	16	None used

Construction Materials

SAND AND GRAVEL—Price for cargo or carload lots to contractor f.o.b., per cu.yd. is as follows:

	Gravel 1½ In. Aug. 5	Gravel 1½ In. One Year Ago	Gravel ¾ In. Aug. 5	Gravel ¾ In. One Year Ago	Sand Aug. 5	Sand One Year Ago
New York (*alongside dock*)	$1.75	$1.75	$1.75	$1.75	$1.00	$1.00
Denver	1.90	1.90	1.90	1.90	1.00	1.00
Chicago	1.60	1.50	1.60	1.50	1.40	1.40
St. Louis	1.45	1.45	1.45	1.45	1.08	1.18
Seattle	1.50	1.50	1.50	1.50	1.50	1.50
Dallas	2.38	2.38	2.38	2.38	2.00	2.00
Minneapolis	1.65*	1.65*	1.65*	1.65*	1.25	1.25
Cincinnati	*1.30*†	1.40†	*1.30*†	1.40†	*1.05*†	1.35†
San Francisco	1.80	2.15	1.80	2.15	1.40	1.50
Boston	1.50†	1.50†	1.50†	1.50†	1.00†	1.00†
New Orleans	3.00	2.60	3.00	2.60	1.80	1.75
Los Angeles	1.15†	.85*†	1.15†	.85*†	1.10†	.50*†
Atlanta	1.90†	1.90†	1.90†	1.90†	1.50†	1.40†
Detroit	1.45†	2.02	1.35†	2.02	1.10†	1.62
Baltimore	1.40	1.40	1.60	1.60	.70*†	.70*†
Montreal	1.25†	1.25†	1.50†	1.25†	1.25†	1.25†
Birmingham	2.00	2.00	2.00	2.00	*1.45*	1.25†
Philadelphia	2.10	2.10	2.10	2.10	1.50	1.50
Kansas City	4.00‡	4.00‡	4.00‡	4.00‡	.66*†	.66*†

New York—Grits, $1.75 per cu.yd.; ready mixed $1.85.
* At pit † Per ton. ‡ Joplin chats.

CRUSHED STONE—Price for cargo or carload lots, per cu.yd. f.o.b. city, is as follows:

	1½ In. Aug. 5	1½ In. One Year Ago	¾ In. Aug. 5	¾ In. One Year Ago
New York	$1.75	$1.75	$1.85	$1.85
Chicago	1.70	1.10	1.87½	1.35
St. Louis	1.83*	1.83*	1.93*	1.83*
Dallas	2.40	2.40	2.83	2.83
San Francisco	1.70	2.15	1.70	2.15
Boston	1.60*	1.60*	1.60*	1.60*
Minneapolis	1.75	1.75	1.75	1.75
Kansas City	2.00	1.50	2.00	1.50
Denver	2.50	2.50	2.50	2.50
Seattle	3.00	3.00	3.00	3.00
Atlanta	2.50*	2.00*	2.50*	2.00*
Cincinnati	*1.65*†	1.90†	*1.65*†	1.90†
Los Angeles	1.40*	1.00*	1.40*	1.00*
Detroit	2.00*	1.90	2.00*	1.90
Baltimore	*2.45*	2.50	*2.50*	2.55
Montreal	1.80*	1.80*	1.70*	.....
Philadelphia	2.10	2.10	2.10	2.10
Pittsburgh	2.85	2.85	2.85	2.85
Cleveland	2.70*	3.25*	2.70*	3.25*
Birmingham	2.00	2.00	2.00	2.00

* Per ton.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plant

	1½-In	¾-In.	Roofing Sand	
Youngstown District	$1.30	$1.40	$2.00	$1.30
Steubenville District	1.25	1.30	2.00	1.30
Ironton District	1.40	1.40	2.00	1.40
Birmingham, Ala	.80@.90	1.15	2.05	.....
Cleveland, Ohio	1.80	1.80	.....	1.75
Eastern Pa. and Northern N. J	1.25	1.25	2.50	1.25
Western Pennsylvania	1.25	1.25	2.00	1.25
Toledo, Ohio	1.25	1.25	1.50	1.25

LIME—Warehouse prices:

	Hydrated, per Ton Finishing	Hydrated, per Ton Common	Lump, per Barrel Finishing	Lump, per Barrel Common
New York	$18.20	$11.00	$3.50*	$2.10@3.00*
Chicago	20.00	18.00	.....	2.25*
St. Louis	23.50	19.50	.....	2.03*
Boston	*19.00*	*12@13*	*3.65*	2.95*
Dallas	20.00	.....	.....	1.85†
Cincinnati	16.80	*11.90*	.....	*11.40*‡
San Francisco	.....	22.00	.....	1.60†
Minneapolis	25.50	21.00	.....	1.60@1.70†
Denver	24.00	.....	.....	2.70*
Detroit	18.50	15.00	.....	18.50‡
Seattle, *paper sacks*	24.00	.....	2.80†	.....
Los Angeles	25.00	18.00	3.50*	19.50‡
Baltimore	24.25	17.85	2.55†	.....
Montreal	.....	21.00	.....	10.00‡
Atlanta	23.50	13.00	2.20†	1.50†
New Orleans	24.00	15.00	2.50†	2.00*
Philadelphia	23.00	16.00	.....	.....
Kansas City	18.50	17.50	*2.45*†	*2.10**
Birmingham	22.50	16.00	2.40†	1.85†

* Per 280-lb. bbl. (net). † Per 180-lb. (net). ‡ Per ton.

NATURAL CEMENT—Price to dealers per bbl. for 500 bbl. or over, exclusive of bags:

	Aug. 5	One Year Ago
Minneapolis (Rosendale)	$2.80	$2.80
Kansas City (Ft. Scott)	1.59	1.35
Cincinnati (Utica)	1.72	1.72
Boston (Rosendale)	2.60	2.50
St. Louis (Carney)	2.35	2.30
Birmingham (Magnolia) pozzolan cement	2.40	2.40

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots f.o.b. points listed *without bags*. Cash discount not deducted.

	Aug. 5	One Month Ago	One Year Ago
New York, del. by truck	$2.50@$2.60	$2.50@$2.60	$2.50@$2.60
New York, alongside dock to dealers	2.15	2.15	2.15
Jersey City	2.33	2.33	2.53
Boston	*2.30*	2.35	2.45
Chicago	2.10	2.10	2.20
Pittsburgh	2.09	2.09	2.19
Cleveland	2.29	2.29	2.39
Detroit	2.15	2.15	2.35
Indianapolis	2.29	2.29	2.39
Milwaukee	2.25	2.25	2.35
Duluth	2.09	2.09	2.19
Peoria	2.27	2.27	2.37
Cedar Rapids	2.34	2.34	2.44
Davenport	2.29	2.29	2.39
St. Louis	2.20	2.20	2.30
San Francisco	2.31	2.31	2.31
New Orleans	2.30	2.30	2.40
Minneapolis	2.32	2.32	2.42
Denver	2.85	2.85	2.84
Seattle	2.65	2.65	2.65
Dallas	2.05	2.05	2.05
Atlanta	2.35	2.35	2.40
Cincinnati	2.37	2.37	2.47
Los Angeles	2.30	2.30	2.52
Baltimore	2.35	2.35	2.50
Birmingham	2.40	2.40	2.40
Kansas City, Mo	*2.0¢*	2.35	2.30
Montreal	1.15	1.15	1.80
Philadelphia	2.41	2.41	2.41
St. Paul	2.32	2.32	2.42
Toledo	2.20	2.20	2.40

NOTE—Bags 10c. each, 40c. per bbl.; 20c. each in Canada, 80c. per bbl.

Current mill-prices per barrel in carload lots, without bags, to contractors:

Buffington, Ind	$1.85	Hudson, N. Y	$2.05
Universal, Pa	1.85	Leeds, Ala	1.95
Steelton, Minn	1.90	Hannibal, Mo	1.95
Fordwick, Va	2.05	Lehigh Valley District	1.95
Mitchell, Ind	1.95	Wyandotte, Mich	1.90
Iola, Kan	1.85	Alpena, Mich	1.75
Mason City, Ia	1.90	Richard City, Tenn	2.05
La Salle, Ill	1.95	Kingsport, Tenn	2.05

E. N.-R. Prices of Construction Materials

TRIANGLE MESH—Price per 100 sq.ft. in carload lots:

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago District Mill	Warehouse: New York	St. Louis	Dallas	San Francisco
032	22	$0.97	$1.01	$1.39	$1.06	$1.13	$1.22
049	28	1.23	1.29	1.76	1.35	1.38	1.55
068	35	1.51	1.58	2.16	1.66	1.67	1.91
093	45	1.94	2.03	2.77	2.13	2.00	2.46
126	57	2.39	2.51	3.45	2.63	2.55	3.03
153	68	2.86	2.99	4.11	3.14	3.15	.....
180	78	3.28	3.43	5.70	3.60	3.47	.....
245	103	4.33	4.53	6.21	4.75	4.58	.....
287	119	5.00	5.24	7.19	5.50	5.26	6.35
336	138	5.80	6.07	8.35	6.37	6.11	.....
395	160	6.72	7.04	9.65	7.38	7.12	.....

PAVING

036P	17	$0.74	$0.77	$1.06	$0.81	$0.76	.....
053P	24	1.04	1.09	1.50	1.14	1.07	.....
072P	31	1.32	1.38	1.90	1.45	1.39	.....
097P	40	1.70	1.78	2.45	1.87	1.90	.....
049R	24	1.04	1.09	....	1.14	1.07	.....
067R	31	1.32	1.38	....	1.45	1.39	.....
089R	40	1.70	1.78	....	1.87	1.90	.....

In rolls, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher. Size of roll carried in New York warehouses, 48 in. wide x 150 ft. long, or 600 sq.ft.

EXPANDED METAL LATH—Prices in carload lots per 100 yd. for painted:

Weight in pounds	New York	Birmingham	Chicago	St. Louis	San Francisco	Dallas
2.2	$17.00	$19.50	$17.50	$17.00	$19.00	$23.50
2.5	18.50	21.50	19.00	18.50	21.00	25.00
3.0	21.50	24.50	22.00	21.50	24.50	28.50
3.4	23.50	27.50	24.00	23.50	27.00	31.00

BARS, CONCRETE REINFORCING—Current quotations per 100 lb., in carload lots, f.o.b. Pittsburgh mill, Birmingham mill, and Chicago and San Francisco warehouses; less-than-carload lots at warehouses in other places named:

ROLLED FROM BILLETS

Inches	Pittsburgh Mill	Birmingham	Warehouse: New York	Chicago	St. Louis	Dallas	San Francisco
½ and larger	$1.90@2.00	$2.00	$3.24	$2.60	$3.15	$3.38	$2.95
⅝	2.00@2.10	2.10	3.34	2.70	3.25	3.43	3.05
¾	2.10@2.20	2.20	3.44	2.80	3.35	3.48	3.15
⅞	2.30@2.40	2.40	3.64	3.00	3.55	3.63	3.35
1	2.90@3.00	3.30	4.24	3.60	4.15	3.78	3.95

For standard classification of extras for size and cutting of steel bars, see bar card of July 15, 1923.

ROLLED FROM RAILS

	St. Louis	Dallas		St. Louis	Dallas
½ in and larger	$2.35	$2.80	½	$2.75	$3.02
⅝	2.45	2.85	¾	3.35	3.20
⅞	2.55	2.90		....	.....

BRICK—Contractors price per 1,000 in cargo or carload lots is as follows:

	Common: Aug. 5	One Month Ago	One Year Ago	Paving Block: 3-inch*	3½-inch*
New York (del.)	$20.40@22.40	$20.40	$18@19	$45.00	$51.00
New York (at dock)	17.00@19.00	17.00	15@16	.....	.....
Chicago	12.00	12.00	12.00	42.00	45.00
St. Louis, salmon (del.)	16.00	16.00	16.00	40.00	42.50
Denver, salmon	10@12	12.00	12.00	.....	.....
Dallas	14.10	14.10	11.60	35.00	.....
San Francisco	15.00	15.00	15.50	.....	.....
Los Angeles	9.00	9.00	11.50	(not used)	
Boston (del.)	18.50	18.50	18.00	45.00	50.00
Minneapolis (del.)	13.75	13.75	13.50	.....	.....
Kansas City	13.50	15.00	14.50	(no market)	
Seattle	15.00	15.00	15.00	.....	42.50
Cincinnati	15.50	17.00	17.00	40.00	45.00
Montreal	17.50	17.50	17.50	100.00†	68.00
Detroit (del.)	16.00	16.00	16.00	38.40	41.50
Baltimore	18.00	18.00	18.00	40.00	45.00
Atlanta	10.50	10.50	10.50	40.00	.....
New Orleans	15.00	15.00	15.00	.....	50.00
Birmingham	14.50	12.50	12.50	40.00	45.00
Philadelphia	19.00	17@19	19.00	40.00	50.00
Pittsburgh (del.)	16.00	16.00	16.00	.....	.....
Cleveland	12@14	16.00	14.00	.....	.....

*For paving blocks 3x8½x4 and 3½x8½x4 respectively. †Imported.

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York: Aug. 5 on Trucks*†	New York: One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco†	Perth Amboy N. J., Factory*
4x12x12	$0.1112	$0.1162	$0.075	$0.105	$0.07	$0.108	.....
6x12x12	.1667	.1743	.096	.....	.094	.156	.....
8x12x12	.2084	.2179	.135	.205	.128	.244	.....
10x12x12	.....	.....	.167	.....	.16	.....	$0.252
12x12x12	.....	.....	.215	.....	.19	.....	.312

*5 per cent off for cash. †Partition tile.

	4x12x12	8x12x12	12x12x12
Boston	$0.085	$0.175	.....
Minneapolis (f.o.b. cars)	.068	.1175	$0.205
Minneapolis (delivered)	.076	.13	.225
Cincinnati	.064	.1295	.1726
Kansas City	.07485	.13745	.225
Denver	.075	.155	.188
Seattle (delivered)	.09	.18	.26
Los Angeles	.085	.172	.....
New Orleans	.13	.20	.35
Detroit (delivered)	.1095	.2053	.2821
Montreal	.12	.....	.....
Baltimore	.124	.268	.....
Atlanta	.0895	.1837	.....
Dallas	.112	.19	.31
Birmingham	.11	.124	.....
Pittsburgh (delivered)	.068	.128	.179
Cleveland	.062	.149	.....

STRUCTURAL MATERIAL—Following are base prices per 100 lb in carload lots, f.o.b. mill, Pittsburgh and Birmingham, together with quotations in less-than-carload lots from warehouses at places named:

	Pittsburgh Mill	Birmingham	Warehouse: New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	$1.90@2.00	$2.00	$3.34	$4.15	$3.25	$3.10	$3.30
Channels, 3 to 15 in.	1.90@2.00	2.00	3.34	4.15	3.25	3.10	3.30
Angles, 3 to 16 in., ¼ in. thick	1.90@2.00	2.00	3.34	4.15	3.25	3.10	3.30
Tees, 3 in. and larger	1.90@2.00	2.00	3.34	4.15	3.35	3.10	3.30
Plates, ¼ in. thick and heavier	1.90	2.00	3.34	4.15	3.25	3.10	3.30

RIVETS—The following quotations are per 100 lb.:

STRUCTURAL

	Pittsburgh Mill	Warehouse: New York Aug. 5	New York One Yr. Ago	Chicago	St. Louis	San Francisco	Dallas
½ in.	$2.50@2.60	$4.20	$4.50	$3.50	$3.65	$5.00	$4.75

CONE HEAD BOILER

½ in.	2.90	$4.40	$4.70	$3.70	$3.85	$5.20	$5.00
⅝ and ¾	3.05	4.55	4.85	3.80	4.20@4.45	5.35	5.15
⅞ and 1	3.30	4.80	5.10	4.05	4.60	5.60	5.50

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh Mill	Birmingham	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$2.65	$2.65	$3.05	$3.75	$4.25	$2.93	$4.95
Cut	2.80	2.80	....	5.30	5.00	3.15	5.00

SHIP SPIKES—Current prices per 100 lb.:

In.	San Francisco: Galv.	San Francisco: Black	Seattle Black
½	$7.50	$5.75	$7.75
⅝	7.05	5.30	5.65
¾	6.90	5.15	5.50

Pittsburgh base in lots of 200 kegs or more, $3.25.

PREPARED ROOFINGS—Slate-surfaced roofing in rolls of 108 sq.ft. costs $2.35@$2.50 per roll to contractors in carload lots f.o.b. New York.

Single shingles, slate finish, cost $7.00 per square (sufficient to cover 100 sq.ft.) in carload lots, f.o.b. New York. Strip shingles (4 in 1) f.o.b. New York, in carload lots to contractors, $5.00 per square.

ROOFING MATERIALS—Prices f.o.b. New York, to contractors in carload lots:

Tar felt (14 lb. per square of 100 sq.ft.) per ton	$70.00
Asphalt roofing (in barrels) per ton	25.00
Asphalt felt, per ton	72.00

WINDOW GLASS—United inches, 25, bracket size 6x8 to 10x15, single thickness "AA," 83 per cent; "A," 87 per cent; "B," 89 per cent. Double thickness "AA," 82 per cent; "A," 86 per cent; "B," 89 per cent discount from jobbers list at New York warehouses.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	$2.30	$3.60	$3.50	$3.90	$3.89
No. 12	2.35	3.65	3.55	3.95	3.94
No. 14	2.40	3.70	3.60	4.00	3.99
No. 16	2.50	3.80	3.70	4.10	4.09
Black					
*Nos. 18 to 20	$2.80@2.95	4.40	3.90	4.70	4.30
*Nos. 22 to 24	2.85@3.00	4.45	3.95	4.75	4.35
*Nos. 26 and 27	2.90@3.05	4.50	4.00	4.80	4.40
*No. 28	3.00@3.15	4.60	4.10	4.90	4.50
Galvanized					
No. 10	3.20@3.30	4.70	4.25	5.00	4.65
Nos. 12 to 14	3.30@3.40	4.80	4.35	5.10	4.75
No. 16	3.45@3.55	....	4.50	5.25	4.90
Nos. 18 to 20	3.60@3.70	5.10	4.65	5.40	5.05
Nos. 22 to 24	3.75@3.85	5.25	4.80	5.55	5.20
*Nos. 26 and 27	3.90@4.00	5.40	4.95	5.70	5.35
*No. 28	4.20@4.30	5.70	5.25	6.00	5.65

* For painted corrugated sheets add 30c. per 1,000 lb. for 5 to 28 gage; 25c. for 19 to 24 gages; for galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per 7½-lb. gallon:

	New York: Aug. 5	New York: One Year Ago	Chicago: Aug. 5	Chicago: One Year Ago
Raw in barrels, (5 bbl. lots)	$0.94	$1.01	$0.95	$0.95@1.00

E. N.-R. Prices of Construction Materials

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry		In Oil	
	Aug. 5	1 Yr. Ago	Aug. 5	1 Yr. Ago
Red	$15.25	$15.75	$16.75	$17.25
White	15.25	15.75	15.25	15.75

Lumber

Prices wholesale, per M. ft. b.m., to dealers in carload lots, f.o.b.

San Francisco—Prices of rough Douglas fir No. 1 common, in carload lots to contractors at yards.

	6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$26.00	$27.00	$28.00	$31.00
3x6 and 8	26.00	27.00	28.00	31.00
4x4-6 and 8	26.00	27.00	28.00	31.00
3x10 and 12	26.00	27.00	28.00	31.00
3x14	30.00	30.00	32.00	34.00
4x10 and 12	26.00	27.00	28.00	31.00
4x14	30.00	30.00	32.00	34.00

	24 Ft. and Under	25 to 32 Ft.	33 to 40 Ft.
6x10	$28.00	$30.00	$32.00
6x14	34.00	36.00	38.00
8x10	28.00	30.00	32.00
8x14	34.00	36.00	38.00

New York and Chicago—Wholesale prices to dealers of long leaf yellow pine.

	New York		Chicago	
	20 Ft. and Under L.L.Y.P.	22-24 Ft. L.L.Y.P.	20 Ft. and Under No. 1 L.L.Y.P.	Up to 32 Ft. No. 1 Douglas Fir
3x4 to 8x8	$43.00	$44.00	$41.50	$40.50
3x10 to 10x10	50.00	51.00	47.50	40.50
3x12 to 12x12	57.00	58.00	57.50	40.50
3x14 to 14x14	65.00	66.00	.....	40.50
3x16 to 16x16	77.00	78.00	.....	42.00

New York—Wholesale price of long-leaf pine (merchantable) to dealers; to contractors, delivered from lighters or cars to job, $5@$10 additional. Short-leaf pine costs $3 per M. ft. less

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 32 ft. and $1 for each additional foot from 32 to 36 ft.

Other Cities

	8x8-In. x 20 Ft. and Under				12x12-In. 20 Ft. and Under	
	P.	Fir*	Hemlock	Spruce	P.	Fir*
Boston	$50.00	*$48.00*†	$50.00	*$50.00*	$60.00]	$58.00†
Seattle	.....	24.00	.....	.....	.....	23.00
New Orleans	35.00	.....	.....	.....	43.00	.....
Baltimore	32.50	49.25	53.00	60.00	38.00	49.75
Cincinnati	37.00	73.00	73.00	85.00	48.00	77.00
Montreal	50.00	58.00	.....	.....	60.00	65.00
Los Angeles	.....	36.64	.....	.....	.....	36.64
Denver	.....	36.25	34.75	34.75	.....	34.75
Minneapolis	41.00	38.25	**34.50**	.....	43.00	*38.50*
Atlanta	31.00	.....	.....	.....	34.00	.....
Dallas	56.00	.....	.....	.....	56.00	.....
Kansas City, M	44.50	**45.75**	.....	.....	59.50	**45.75**
Birmingham	**35.00**	.....	.....	.....	**40.00**	.....
Philadelphia	54.00	36.00	38.00	45.00	65.00	36.00
Detroit	47.75	46.75	.....	.....	61.75	46.75
St. Louis	*40.00*	.....	.....	.....	*52.00*	.....

	1-In. Rough, 10 In. x 16 Ft. and Under			2-In. T. and Gr. 10 In. x 16 Ft.	
	P.	Fir*	Hemlock	P.	Fir*
Boston	$46.00	*$42.00*†	$45.00	$50.00	$48.00†
Seattle	.....	22.00	.....	.....	24.00
New Orleans	72.50	.....	.....	45.00	.....
Baltimore	55.00	44.00	44.00	34.00	50.00
Cincinnati	70.00	79.00	75.00	38.00	85.00
Montreal	45.00	50.00	40.00	65.00	50.00
Los Angeles	.....	35.64	.....	.....	
Denver	.....	33.25	33.25	.....	31.25
Minneapolis	42.50	36.25	34.75	35.00	34.25
Atlanta	22.00	.....	.....	28.00	.....
Dallas	**52.25**	.....	.....	56.00	.....
Kansas City, Mo	*51.25*	**48.75**	.....	**44.00**	**40.75**
Birmingham	**30.00**	.....	.....	42.00	.....
Philadelphia	*30.00*	36.00	**36.00**	*45@48*	35.00
Detroit	39.75	37.00	.....	46.50	41.25
St. Louis	*41.00*	.....	.....	*28.50*	.....

Birmingham—Quotes carload lots, f.o.b. sidings; $4.00 additional per M. ft. to contractors.
Boston and Cincinnati—Prices to contractors in carload lots, f.o.b.
Denver—Quotes dealers price to contractors on large projects.
St. Louis—Wholesale price to contractors, f.o.b. cars, $2 per M.ft. additional.
Seattle—Price to contractors, delivered.
Dallas—Wholesale to contractors, $10 per M.ft. additional.
*Douglas fir. †Prime.

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York.

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23½
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36½
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41

Miscellaneous

STEEL SHEETPILING—The following price is base per 100 lb. f.o.b. Pittsburgh, with a comparison of a month and a year ago:

Aug. 5	One Month Ago	One Year Ago
$2.25@$2.30	$2.25@$2.30	$2.25@$2.30

CONCRETE MASONRY UNITS—Standard 8x8x16-in., delivered to job, each

Denver	$0.22	St. Louis	$0.18*
Detroit	.16	Boston	.22
New Orleans	.23	Minneapolis	.18*
New York (Brooklyn)	.18@.20	Philadelphia	.18@.26*
Pittsburgh	*1¼*	*F.o.b.	

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	Eastern Territory New York and East of Missouri River
Plow steel round strand rope	35%
Special steel round strand rope	30%
Cast steel round strand rope	20%
Round strand iron and iron tiller	5%
Galvanized steel rigging and guy rope	7½%
Galvanized iron rigging and guy rope	+12½%

California, Oregon, Nevada and Washington: Discount 5 points less than discount for Eastern territory.
Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.
Arizona: Discount 10 points less than discount for Eastern territory.
Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.
North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¾-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ⅜-in., 8 ft.; ½-in., 6; ⅝-in., 4½; ¾-in., 3½; 1-in., 2½; 1¼-in., 2 ft. 10 in.; 1½-in., 2 ft. 4 in. Following is price per pound for ½-in. and larger, in 1200-ft. coils:

Boston	$0.21	New Orleans	$0.23½
New York	.25	Los Angeles	.25
Chicago	.22½	Seattle	.24
Minneapolis	.24½	St. Louis	.24½
San Francisco	.25	Montreal	.16
Atlanta	.27	Detroit	.24½
Denver	.24@.25	Baltimore	.18
Cincinnati	.21	Kansas City	.28
Dallas	.31	Birmingham	.26@.27
Philadelphia	.25		

EXPLOSIVES—Price per pound of dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.265*	$0.2875*
Boston	.23	*.25*
Kansas City	.2025	**.2225**
Seattle	.165	.19
Chicago	.195†	.2175†
Minneapolis	.1917	.2123
St. Louis	.22	.245
Denver	.2025	.2275
Dallas	.225	.302
Los Angeles	.1875	.2225
Atlanta	.215	.24
Baltimore	.22	.23
Cincinnati	.22	.245
Montreal	.195	.235
Birmingham	.22	.24
New Orleans	.233	.26
San Francisco	.1625	*.1922*
Philadelphia	.215	.24

*Special gelatin. †Quantities above 500. lb. and less than a ton.

CHEMICALS—Water and sewage treatment chemicals, spot shipments in carload lots, f.o.b. works:

Sulphate of aluminum, in bags, per 100 lb	$2.00@$2.10
Sulphate of copper, in bbl., per 100 lb	4.85@5.00
Soda ash, 58%, in bags, per 100 lb	1.38@1.55
Chlorine, liquid, tanks, per lb	.04@.04½
Hypochlorite of lime (bleaching powder) in drums, per 100 lb	2.00@2.10

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb.:

Atlanta	$0.58	Detroit	$0.29
Baltimore	.31	Kansas City	.735
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15*
Chicago	.34	Philadelphia	.32
Cincinnati	.29	St. Louis	.43
Cleveland	.19	St. Paul	.60
Denver	1.15*		

* Minimum carload, 50,000 lb., structural steel only; 80,000 lb., for other iron or steel products.